A framework for designing South African mobile learning experiences through a participatory design process

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(i) Declaration

I hereby acknowledge that I am aware of the University's policies regarding plagiarism. I understand fully what plagiarism involves and declare that this assignment is entirely my own work. I have acknowledged and cited all sources, including internet websites. I agree that if either a lecturer or tutor suspects that I may have committed plagiarism, my assignment will immediately become subject to a departmental review process in terms of departmental and university procedures. I understand that if I am found guilty of plagiarism, I am liable to face disciplinary actions as spelt out in the Department of Visual Art's Policy on Plagiarism and Referencing, and that if the matter goes to a formal University disciplinary hearing, this could lead to my expulsion from the module or University or to facing other disciplinary action as governed by University rules.

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(ii) Abstract

With a global trend towards digital and mobile learning in basic education, which has been recently spurred on by the global COVID-19 pandemic, the South African government has committed to large-scale implementations of digital classrooms, tablet PCs for learners, and other technology-based educational strategies. However, it is concerning to see how similar attempts made by the educational sector of first world countries, such as the United States of America, have not met the expectations they set out to achieve. It is believed that the results might stem from a disconnect between the technology and the users, as seen by the lack of on-boarding and the unsustainable use of learning technologies in these countries.

The aim of this research is therefore to cultivate a deeper understanding of the development of mobile learning experiences, specifically within the context of South Africa, in an attempt to address the reasons behind the shortfalls. Both the theoretical research and the participatory design engagement will be framed by a socio-materialistic perspective, which offers a mechanism that places equal importance on both the social aspects (environment, culture, ideology) and material aspects (infrastructure, technology, connectivity) of the research. This approach will afford the opportunity to consider all aspects that influence mobile learning in a view of equal importance.

The research puts forward a design framework to guide a school's implementation strategy and methodology, which will be based on the findings of individual and participatory design engagements with stakeholders from technology-based industries, as well as teachers. It is hoped that the design framework and the observations made in this study will inform the future attempts at developing digital mobile learning platforms and content, which will be relevant and meaningful to those who use them.

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(iii) Opsomming

Met 'n wêreldwye neiging tot digitale en mobiele leer in basiese onderwys, wat onlangs deur die wêreldwye COVID-19-pandemie aangespoor is, het die Suid-Afrikaanse regering hom verbind tot grootskaalse implementering van digitale klaskamers, tabletrekenaars vir leerders, en ander tegnologie-gebaseerde opvoedkundige strategieë. Dit is egter kommerwekkend om te sien hoe soortgelyke pogings wat deur die opvoedkundige sektor van eerstewêreldlande, soos die Verenigde State van Amerika aangewend is, nie aan die verwagtinge voldoen het wat hulle beoog het om te bereik nie. Daar word geglo dat die resultate kan voortspruit uit 'n ontkoppeling tussen die tegnologie en die gebruikers, soos gesien deur die gebrek aan aanboord en die onvolhoubare gebruik van leertegnologieë in hierdie lande.

Die doel van hierdie navorsing is dus om 'n dieper begrip van die ontwikkeling van mobiele leerervarings te kweek, spesifiek binne die konteks van Suid-Afrika, in 'n poging om die redes agter die tekorte aan te spreek. Beide die teoretiese navorsing en die deelnemende ontwerpbetrokkenheid sal omraam word deur 'n sosio-materialistiese perspektief, wat 'n meganisme bied wat gelyke belang plaas op beide die sosiale aspekte (omgewing, kultuur, ideologie, ens.) en materiële aspekte (infrastruktuur, tegnologie, konnektiwiteit ens.) van die navorsing. Hierdie benadering sal aan die navorser die geleentheid bied om alle aspekte wat mobiele leer beïnvloed in 'n oog van gelyke belang te oorweeg.

Die navorsing sal 'n ontwerpraamwerk voorstel om 'n skool se implementeringstrategie en -metodologie te rig, wat gegrond sal wees op die bevindinge van individuele en deelnemende ontwerpbetrokkenheid met belanghebbendes van tegnologie-gebaseerde industrieë, sowel as onderwysers. Daar word gehoop dat die ontwerpraamwerk en die waarnemings wat in hierdie studie gemaak is, die toekomstige pogings tot die ontwikkeling van digitale mobiele leerplatforms en inhoud sal inlig, wat relevant en betekenisvol sal wees vir diegene wat dit gebruik.

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(iv) Acknowledgements

I would like to thank my supervisor, Dr. Karolien Perold-Bull for her unwavering patience, guidance and support throughout this difficult journey. I would also like to thank the individual research participants whose insights and contributions made this study possible. Lastly, I thank my family, friends and colleagues who have supported me in this undertaking.

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(viii) Preface

From my own perspective, millennials like myself who were born between 1981 and 1996 (Dimock, 2019) with our tech-savvy doodads[1] have entered the workplace and most of us are on the trajectory to start our own families – such is life. One would think that the future we read about, during the dawn of the millennium, has brought us flying cars and smart gadgetry that has diminished all the mundane day-to-day tasks, providing us and the future generation with the ability and possibilities to excel beyond our imagination.

Disappointingly, in South Africa the futuristic utopia we anticipated has left us high and dry. Our children's school-teleportation-devices are still minibus taxis that are overcrowded and unroadworthy (Sain, 2019). Their high-tech-knowledge-gismos are still delivered in paperback a few months after the school year has already started (Mamokgere, 2019). Their space-aged-Miesian[2] educational environments are still unsound with no electricity or running water or even worse, in the open-air under a tree (Times Live, 2018).

As a future parent or guardian it is frustrating to see how the cards are stacked against the youth in South Africa in terms of the availability of and access to education, while the government continuously fails to deliver workable solutions for the promise of digital and paperless classrooms for all South African learners (Mybroadband, 2019).

The current state of the South African educational system reminds me of the saying by Maslow: "...if the only tool you have is a hammer, to treat everything as if it were a nail" (1966:15). With that in mind, I feel that we, as parents and as researchers, designers, developers and engineers have the responsibility to find alternative tools that may help alleviate these challenges and set a course for a worthier future for the next generation.

This is my attempt.

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1 A gadget or other object the name of which the speaker does not know or cannot recall (Oxford Dictionary, 2021).

2 Miesian is a term used to describe the utopian architecture that was inspired by or built in the style of the vastly influential 20th century architect, Ludwig Mies van der Rohe (DAHP, 2020).

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(ix) Outline of Research

This research thesis consists of the following six chapters, as outlined in Table 1.

Table 1: Research outline.

Chapter:	Summary of Contents:
Chapter 1: Background and Context	The first chapter of this research thesis will give an overview of digital and mobile learning in South Africa, state the research aims and objectives and contextualise the research topic. This will be followed by a brief overview of the research methodology and delimitation of this study, as well as a closing paragraph on the significance thereof.
Chapter 2: Theoretical Perspectives	The second chapter will present a critical discussion on the three major research topics of this study, which include; sociomaterialism, mobile learning and participatory design.
Chapter 3: Methodology	The third chapter of this thesis will discuss the research methodology in more depth, which includes the research paradigm, research sample, research design and the ethical consideration of this study.
Chapter 4: Research Through Participation	The fourth chapter of this thesis, which will respond to the insights gained from Chapter 2: Theoretical Perspectives and framed by the content of Chapter 3: Methodology will discuss the participatory design research, as well as presenting the participatory design research observations and findings.
Chapter 5: Design Framework	The second-last chapter of this thesis, which will respond to the insights gained from Chapter 4: Research Through Participation will discuss the development of the design framework, present the design framework in the form of a practical component and present an assessment conducted through the design framework.

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Chapter 6: Conclusion and Implications	The final chapter of this thesis will present the research findings, highlight the implications of the study and conclude with an overall critique of the study, as well as highlighting further research opportunities in the field of developing frameworks for South African mobile learning experiences.

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Chapter 1: Background and Context

1.1 Introduction

It is evident that technology has vastly augmented the possibilities and opportunities of education. Learning, which prior to the digital era was restricted to classrooms and other physical environments, has now become intertwined with mobile and digital environments. The trend of mobility in the learning environment was seen globally before the COVID-19 global pandemic, through the increase in use of e-books[3], an uptake in online courses, and the increase in the development of mobile learning applications. It is said that 92 per cent of learners worldwide are interested in using mobile and digital technologies in their learning environment (Statista, 2018). This trend has taken a sharp upwards turn since the spread of the coronavirus disease (COVID-19), which reached South Africa in March 2020 (South African Government, 2020).

Even though digital education has remained listed as a national priority since the early 2010s, South Africa's commitment to large-scale implementations of digital and mobile learning in its schools, remains behind the proposed schedules. Every year, the State of the Nation Address announces yet another ‘major overhaul’ for the South African education system; nevertheless, our future generation faces compounded challenges in their current physical environments, which need to be addressed first. However, these challenges are considered almost unsolvable to most (Mybroadband, 2019).

In the attempt to address these challenges, throughout the years the public sector has attempted to establish the use of mobile learning applications as educational resources, as seen by Mxit’s Dr. Math’s and Quizmax applications, as well as Nokia’s ‘Mobile Mathematics Project’, which was developed in collaboration with the South African Department of Education in 2010 (O’Hagan, 2013). These attempts by the public sector and government are commendable; however, it is concerning to see how similar attempts to introduce digital and mobile learning in developed countries have not met the expectations they were set out to achieve. Pinker (2015) explains that the United States’ domestic agenda under President Obama also focused on introducing digital and mobile technologies in the education sector. However, as Pinker notes, the introduction of “more technology in the classroom has long

[3] An e-book an electronic version of a printed book that can be read on a computer or a specifically designed handheld device (Oxford Dictionary, 2021).

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been a policy-making panacea" (2015). There is mounting evidence that suggests technologies with networking functionalities can cause a decline in the reading and mathematics scores of learners in certain socio-economic sectors as it gives access to different forms of entertainment and social media, which often distracts learners from the academic discourse (Ladd & Vigdor, 2010).

It is therefore important that the implementation of mobile learning technologies, especially in South Africa, are seen as educational tools, instead of a 'magical' solution for the country's educational challenges. Logically, for it to be effective, all content produced for a digital educational system, should be developed within the context of the environment it is meant for. Such a task could perhaps also offer opportunities to assist in the alleviations of the persistent consequences of 1949 Bantu Educational Act[4] (Villette, 2019), as well as addressing some of the challenges and shortfalls that the South African Department of Basic Education is currently facing during the ongoing COVID-19 pandemic.

1.2 Research Aims and Objectives

The South African Department of Basic Education is set to be "on track to provide each learner and teacher with an ICT [Information and Communications Technology] device with access to digitized Learning and Teaching Support Materials" (Motshekga, 2019). However, the department still faces challenges at a grassroots level, as seen in the lack of infrastructure (Herman, 2019), hardware and software issues (MyBroadband, 2019), increased levels of crime (Lesufi, 2019), and unqualified teaching staff (MyBroadband, 2018), which all contribute to the non-delivery of promises made in recent State of the Nation addresses.

It is therefore believed that a design process which takes into consideration all key stakeholders and that is sensitive to the social, political, and economic challenges of South Africa, might offer practicable solutions to the challenges facing the educational system. As a response to this notion, this research study will aim to cultivate a deeper understanding of

[4] The 1949 Bantu Educational Act was a South African segregation law which legalised several aspects of the apartheid system, including provision and enforcement of racially separated educational facilities (Moore, 2015).

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the development of mobile learning experiences through a participatory design[5] process that is framed by a sociomaterialistic[6] framework.

In keeping with the aim stated above, this research study will attempt to achieve the following objectives:

a) Establish a sound understanding of the theories of sociomaterialism, mobile learning, and participatory design to develop a suitable research study;

b) Plan and facilitate research engagements between relevant stakeholders to collaboratively develop a possible design framework directed at assisting the industry with the development of South African mobile learning experiences; and

c) Produce a practical draft of a design framework to be presented and tested for further research and/or development.

1.3 Research Topic

In response to the research aims and objectives set out in this thesis, the following topic has been put forward and is contextualised in Table 2.

A framework(a) for designing(b) South African(c) mobile learning experiences(d) through a participatory design(e) process.

Table 2: Research topic contextualised.

Ref:	Context:
(a)	The main aim of the thesis is to propose a design framework, set of recommendations or best practices.
(b)	The proposed design framework is set to guide the entire design process; from the conceptual design phase to the implementation phase.

5 Participatory design is an approach which actively involves all stakeholders in a design process so that the outcome meets the needs of the these stakeholders (IGI Global, 2019).

6 Sociomateriality is a theory built upon the intersection of technology, work and organisation that attempts to understand "the constitutive entanglement of the social and the material in everyday organizational life" (Orlikowski, 2007).

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(c)	The objective is for the design process to take into consideration the economic and socio-political context of South Africa.
(d)	The proposed design framework is set to apply to any type of mobile learning experience that is meant to take the South African context into consideration such as mobile learning apps, websites, and interactive platforms.
(e)	This will be achieved through a participatory design process, which will attempt to take into consideration the inputs of the key stakeholders.

Based on the contextualisation of the research title, one could establish the research question as: *'What possible framework for designing South African mobile learning experiences could be developed through a participatory design process?'*

1.4 Summary of the Research Methodology

Both the theoretical research and the participatory design process have been approached from a relational or flat[7] ontological position, which forms the overarching research paradigm. This approach aligns itself well with the relational nature of the main research topics, which are: sociomaterialism, mobile learning, and participatory design. A more detailed description of the research paradigm (epistemology, ontology, and axiology) is provided in Chapter 3.1 Research Paradigm.

To support the flat ontological position, the study was conducted through research engagements, which included activities that attempted to indirectly gauge key concerns which are indirectly found in the theoretical research. These engagements were conducted with key stakeholders, which included teachers, a software developer, a software analyst, and a software trainer, as outlined in Chapter 3.4 Research Sample. The intent was to include learners in the research study; however, it was unfortunately not possible owing to the shifting school deadlines and pressures on learners as a result of the COVID-19 pandemic lockdowns in South Africa.

[7] A flat ontology takes the position that all entities (or 'actants' as described by the Actor Network Theory) are deserving of equal consideration. In this view, there is no hierarchical structure and no one entity, including humans, is more significant than another (Cooper, Coulton & Lindley, 2017).

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It is important to note that the research was approved by the Stellenbosch University's Research Ethics Committee (Addendum 1) and the Eastern Cape's Provincial Department of Education (Addendum 2). Lastly, all meetings and engagements throughout the research process were done in accordance with the Stellenbosch University's mandated COVID-19 Protocol (Addendum 3).

1.5 Delimitation of Study

The research has been conducted in Nelson Mandela Bay (Eastern Cape, South Africa) with a selected group of research participants. The research has therefore been geographically delimited to Nelson Mandela Bay and further delimited to the experience and expertise of the selected group of research participants.

1.6 Significance of Study

As the implementation of digital and mobile learning has since become governmentally mandated (Mybroadband, 2019), South Africa has a set trajectory and can reflect on the successes and failures of countries which have attempted the implementation of the same or similar initiatives. It is therefore important to note that some of the world's top fifteen wealthiest countries, such as the United States of America (Suneson, 2019), have often failed in their attempts to implement digital and mobile learning in their schools (Pinker 2015). This highlights the possibility that the solutions for the successful and sustainable implementation of digital and mobile learning in schools, might not necessarily rely on access to wealth or technological resources, but other factors that are yet to be fully explored or understood.

With the increased need for workable solutions for digital and mobile learning in schools owing to the pressures of the global COVID-19 pandemic, it is evident that an urgent need exists to gain insight into the factors that influence the design of mobile learning experiences, with special consideration of the context in which they are meant to be used. However, it is important to acknowledge that it is highly unlikely for this study to produce an ultimate solution to all the current challenges facing the South African education sector. It is rather only an attempt to explore the complex relationships between learning and design theories, within the context of a South African sociomaterialistic milieu. It is hoped, however, that the observations made in this study can inform future attempts in the development of digital and mobile learning experiences in a way that is relevant and meaningful to those who use them.

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Chapter 2: Theoretical Perspectives

2.1 Introduction

Aurel explained that “digital education is vital to the country’s future [and that] we cannot succeed by clinging onto an outdated and broken educational system” (2018). Despite the initiatives driving South Africa to keep up with the global shift to digital education during the ‘fourth industrial revolution’[8], as well as the need to fast-track the process owing to the global COVID-19 pandemic, the country still faces major challenges that are compounded by its various social, political, and economic factors.

As mentioned, for all content produced for a digital educational system to be effective, it should logically be developed within the context of the environment for which it is meant. Therefore, to gain insight into the methods and strategies required to develop a possible framework for designing mobile learning experiences that responds well to its environment and intended users, the following three concepts have been explored in this research study: sociomaterialism (as an overarching theoretical perspective); mobile learning (as the main subject of this research); and participatory design (a methodology of designing collaboratively with stakeholders).

2.2 Theory of Sociomaterialism

The term ‘Sociomateriality’ or ‘Sociomaterialism’ came into prominence in 2007 after it appeared in journals related to the fields of organisational and information systems (Jones, 2014). The term refers to a concept that views people, the actions they perform, their organisational structures, as well as the technologies they use, as all "inherently inseparable" or "entangled", which contrasts with the conventional notion that these are separate entities (Barry, 2018).

The concept of entanglement is also described by Barad as intra-action, which is distinct from the term interaction (2003). While interaction refers to individual entities that engage, the entities keep a "level of independence from each other [as] each entity exists before they encounter one another" (Barad, 2003). In contrast, intra-action refers to the occurrence

[8] The fourth industrial revolution is the current and developing environment in which disruptive technologies and trends such as the Internet of Things (IoT), robotics, virtual reality (VR) and artificial intelligence (AI) are changing the way we live and work (Rouse & Wigmore, 2017).

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where "entities materialize through intra-action and the ability to act emerges from within the relationship, not outside of it" (Barad, 2003). Intra-action therefore redefines the way in which we can observe the relationships between entities where the responsibility is distributed amongst the constitutive entities as opposed to interactions, which can defer or deflect responsibilities (Barad, 2003). Importantly, intra-action allows for thoughts and processes that are not pre-determined but are always changing and unfolding. This brings into question the artificial boundaries that society has invented, which often try to limit the entanglement of these relationships.

In the context of the main topic of this research, namely digital mobile learning, Cecez-Kecmanovic's explained that, when one "investigates technology, we need to attend to these entanglements in order to then explore the temporal meaning, boundaries and properties that such technologies entail" (2014). This entanglement is illustrated in Figure 1, which shows how the social, material, and cultural entities can overlap with one another in an environment.

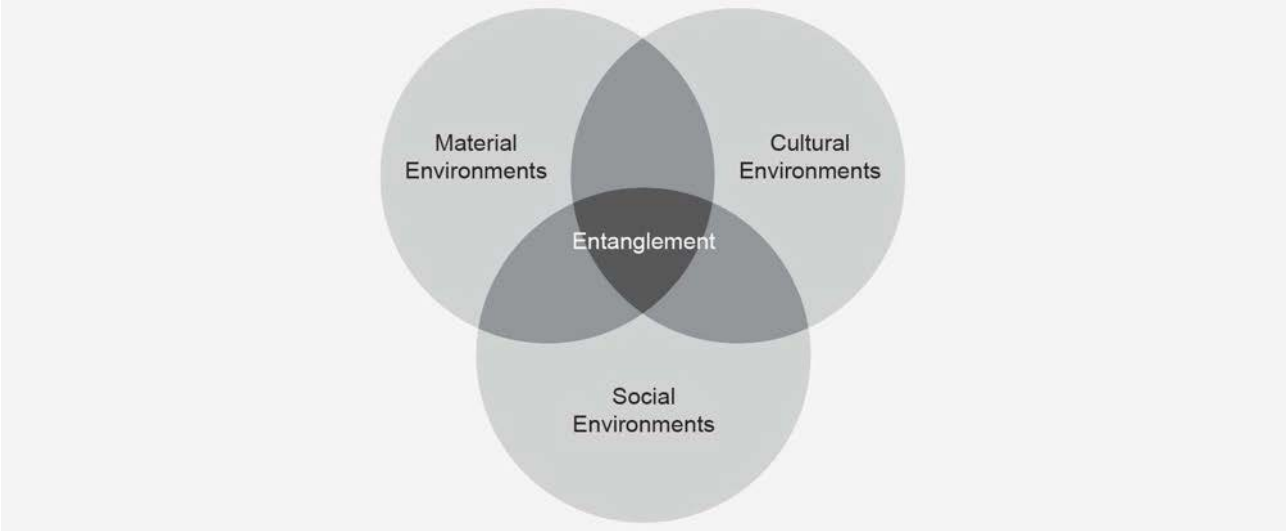

Figure 1: Constitutive entanglement in sociomateriality (Eze, Gleasure & Heavin, 2016).

Even though Cecez-Kecmanovic's definition of sociomaterialism is understood, the term 'temporal' within its definition, gives insight into the complexities and inconsistencies of the relationships and interplays between these entanglements, which are also referred to as "assemblages" (Suchman, 2007) or "mangles" (Pickering, 1995). These relationships and interplays, or "contours", as Doolin and McLeod explained, "can never be completely mapped out in advance", as they are in a constant state of adaptation in the attempt to

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“address obstacles encountered or solve new problems” (2012). To further the complexities of this constant adaptation, Suchman notes that the entanglements between the social and material “are (re)produced differently across different times, places, and participants … [r]ather than a fixed human-artifact relation”, which results in a diverse multiplicity of entanglements (2007). In contrast to the seemingly unadulterated explanations of sociomaterialism, as put forward by the aforementioned authors, Bjørn and Østerlund noted that “some researchers argue that not all technologies have physical presence, while others insist that the opposite is true” (2014). However, to put sociomaterialism into perspective in terms of a designer’s point of view; Bjørn and Østerlund explained that as designers we should "never design, create and build technologies as disconnected entities, and, as such, we should continuously remind ourselves of the relational characteristics of artifacts” (2014).

According to Bjørn and Østerlund, the methodology in understanding sociomaterialism as a theory, is to firstly establish its underlying epistemology[9], ontology[10] and axiology[11] first (2014). Reflecting on Cecez-Kecmanovic’s (2011) definition that emphasises the nature of entanglement between the social and material elements within this field of study, it is acknowledged that the understanding of sociomaterialism requires a relational research paradigm. Orlikowski and Scott, emphasised this point by stating that the “relational ontological perspective of sociomaterialism does not mean that people and technologies only exist in relation to each other” (2008), but rather that “to encapsulate the sociomateriality of the computer” we should study both the human and the technology they operate (Bjørn & Østerlund, 2014). Cecez-Kecmanovic echoed this statement by noting that sociomaterialism is based on a relational ontological perspective, because the social and material aspects "continually co-construct reality and at the same time co-constitute each other" (2016). In support of this, Hultin (2019), explained that the relational underpinning of sociomaterialism has implications relevant to technology, society, materiality, morality, and ethics.

[9] Epistemology: A branch of philosophy that studies knowledge or knowing i.e. ‘How do we know what we claim to know?’ (Lyon, 2016).

[10] Ontology: A branch of philosophy that studies the nature of human beings’ existence as individuals, in society and in the universe i.e. ‘Who are we and what are we here for?' (Lyon, 2016).

[11] Axiology: A branch of philosophy that studies values i.e. ‘What moral values guide the research?’ (Lyon, 2016).

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The goal, according to Jones, behind the articulation of the epistemology, ontology, and axiology with regards to sociomateriality, according to Jones, is that the researcher is afforded the "opportunity to move beyond the privileging of either the social or the material" (2014). This is because, as Leonardi and Barley explain, "classic information system theories tend to promote epistemological, ontological, and axiological positions that fall into either a material determinism[12], overemphasising the material, or an ideological voluntarism[13], favouring the social" (2008). Mol places emphasis on the inseparability of the social and material in support of a relational research paradigm by offering the following poignant statement, namely "to be is to be related" (2002).

Beyond merely establishing the research paradigm most applicable to sociomateriality, Constantinides and Barrett highlighted the challenge of getting to grips with deciphering the constitutive entanglement of the social and the material by posing the following question: "Where does one start, methodologically and analytically, to trace the entanglement"? (2012). Haraway suggested the following metaphor to illustrate an understanding of the constitutive entanglements of these elements:

> *"Approach this entwined ball of yarn by carefully studying particular strings and following these over time to see which relations the strings create. By pulling one string in the ball of yarn and carefully following it through time and history, we get insight into which relations are important for the sociomaterial practices we study"* (Haraway, 1994).

Even though some research refers to sociomaterialism as a modern 'buzzword' (Weißenfels, 2016) or that it has become the 'new black' in research (Jarzabkowski & Pinch, 2013), Bjørn and Østerlund (2014) noted that the concept of the inseparability between social and material components has earlier reference in human geography (Couthern, 1958), sociology (Carver, 1975) and economics (Legoto, 1979). This underscores the importance of considering and understanding the notion of entanglements in the study of design and technology. Sociomaterialism also relates to other prominent theoretical perspectives, according to Orlikowski and Scott (2008), such as the Actor Network Theory (ANT), first developed in the mid-1980's by sociologists Callon and Latour, which parallels the sociomaterialistic views of entanglement and inseparability.

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[12] Determinism is defined as a philosophical perspective that states all events are determined completely by previously existing causes (Doyle, 2011).

[13] Voluntarism is defined as a philosophical perspective that prioritises will over emotions or reason (Will, 1926).

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Walsham (1997) explained that, within the context of the ANT, the ‘actor’ (or actant) refers to both the human elements, such as the users of technology, and non-human elements, such as technological artifacts, while the ‘network’ refers to the heterogeneous network of aligned interest, including people, organisations and standards. Law gives insight into the perspective of the ANT by explaining that, according to this view, “an object is an effect of an array of relations, in which humans and technology are not only reciprocally interdependent, but also systematically relevant” (2000). Therefore, from an ANT perspective, according to Orlikowski and Scott, there are no distinctions between the social and technological elements, and both are considered to be “equivalent participants in a network of human and non-human agencies” (2008). Parmiggiani and Mikalsen maintained that ANT-based perspectives play a major role in the discourse of sociomateriality, “due to ANT being a more mature theoretical scaffold that has been evolving during the last 30-years” (2013). However, the ANT is not without criticism, as seen by Collins and Yearley who argue that “the failure in the theory to make a distinction between human action and the behaviour of things is an abdication of human responsibility” (1992). Callon and Latour responded to the aforementioned authors' criticism and explained that they do not deny differences, but they "refuse to consider them ‘a priori’[14] and treat them all as actants who form part of hybrid networks” (1992).

It is believed that research into the field of mobile learning should allow for the evaluation of all aspects that relate to it, both human and non-human, as these are often inseparable. A sociomaterial perspective will therefore allow the research to be sensitive to the social aspects (engagement, environment, economics) as well as the material aspects (infrastructure, hardware, software) of this study. This could potentially offer more suitable solutions to the challenges facing South African education.

[14] *A priori* is defined as denoting reasoning or knowledge which proceeds from theoretical deduction, rather than from observation or experience (Bird, 1995).

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2.3 Theory of Mobile Learning

In Toffler's predictions about the fourth industrial revolution in his book *Future Shock* (1984), he writes that “the illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn” (1984). The challenge is that learning is not as simple. The methods of learning have been a topic of discussion since Plato proposed the question in c. 400 BC, namely “How does an individual learn something new when the topic is brand new to that person?” or possibly even before then (Silverman, 2014).

Strauss indicated that people learn in a “variety of ways, some from small one-room schools, but many from their mothers, tutors [...], relatives, neighbours, friends" (2016). According to Millwood (2013), the different ways in which people learn were categorised by research on learning theories in the early twentieth century and stem from different scientific disciplines, each defined by their own learning paradigms. Millwood has developed a comprehensive Learning Theories Diagram (Figure 2); however, within the context of sociomaterialism, there appears to be a large overlap in terms of learning theories that take into consideration the environmental and social influences of the learner. Relevant social learning theories can be seen in the fields of: Social Anthropology (Situated Learning), Organisational Theory (Experimental Learning) and Philosophy (Constructivism).

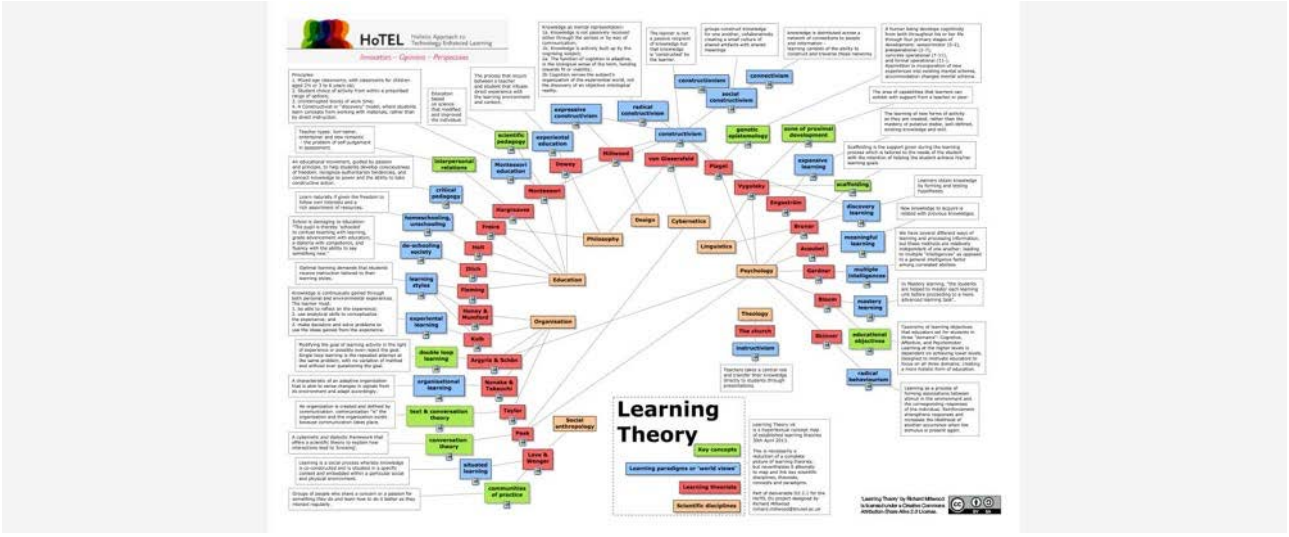

Figure 2: Learning Theories Diagram (Millwood, 2013).

Situated Learning is defined by Millwood (2013) as learning through social processes whereby knowledge is co-constructed and is situated in a specific context and embedded within a particular social and physical environment. Similarly, Experimental Learning is

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defined to be continuously gained knowledge, through both environmental and personal experiences. However, with experimental learning, as Millwood (2013) explained, the learner must be able to reflect on the experience, use analytical skills to conceptualise the experience and make decisions to solve problems through ideas gained from the experience. Within both Situated Learning and Experimental Learning situations, the learning can, and often does, perform a certain level of constructivism, but Constructive Learning specifically focuses on promoting the construction of knowledge by the learner or group of learners through their interactions, environments, and experiences. However, as Millwood (2013) noted, Constructive Learning does not always result in the discovery of an objective ontological reality.

Discourse on learning theories has, however, always been subject to criticism, as seen by notable research papers published in the *Journal of Educational Psychology* (Calhoun, Rogowsky & Tallal, 2015), the *Society for the Teaching of Psychology* (Dobolyi, Hughes & Willingham, 2015), the *British Journal of Psychology* (Knoll, Otani, Skeel & Van Horn, 2017) and the *Anatomical Sciences Education Journal* (Husmann & O'Loughlin, 2018), which all discredit the notion of defined learning theories. The consensus regarding learning theories, according to Willingham (2018), is that individuals learn according to their own abilities and preferences, not styles.

This is why a plethora of learning preferences exists, which are most often combined and intertwined by individuals, much like the notions of entanglement in the theory of sociomaterialism. Wenger supported this view by stating that learning, more specifically social learning, is often “maximized if the learning process supports the identity, meaning, practice and community of the individual” (1998). Wenger offered a visual representation of this entanglement in the Figure 3:

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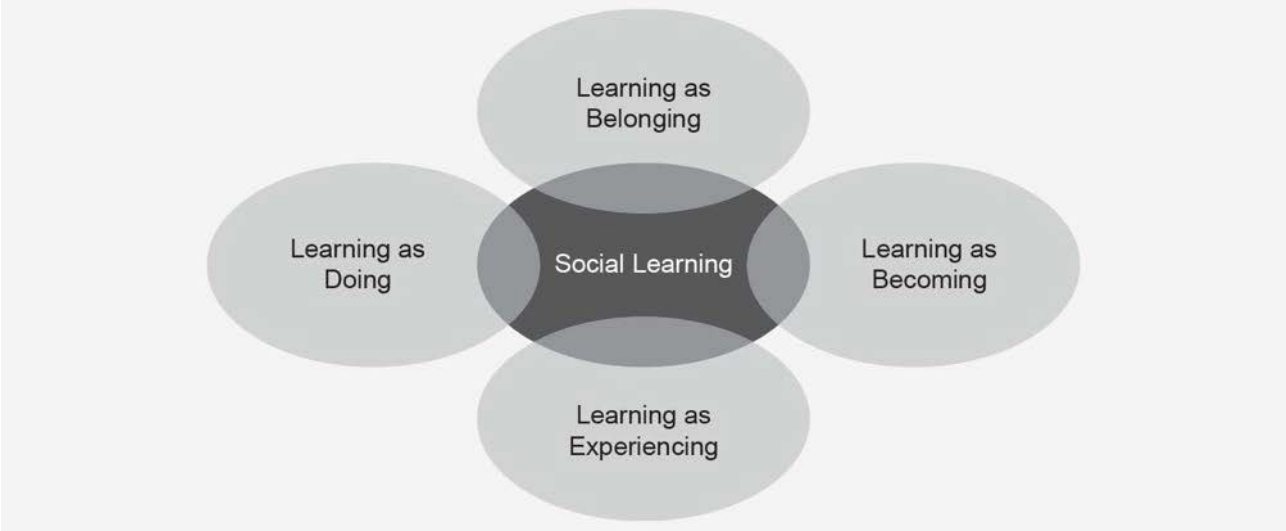

Figure 3: Components of Social Learning (Wenger, 1998).

The components of Social Learning, as presented by Wegner in Figure 3, might have become more complex and intertwined as a result of new opportunities brought about by advancements in technology, and more topically the global COVID-19 pandemic, which has fast-tracked some development processes owing to necessity. The 'social' aspects of learning will most probably be redefined over time, as learning is becoming increasingly more digital with mobile learning at the forefront.

In broad terms, mobile learning can be defined as education or training conducted by means of portable computing devices, such as smart-phones or tablet computers. Some studies, as seen in Traxler's paper entitled *Defining Mobile Learning* (2005), differentiate between the terms 'e-learning' and 'm-learning'[15]. Nonetheless, what is important is that more than a decade later, the core characteristics that define digital learning are still portability, connectivity, personalisation, interactivity, and content adaptability, which all fosters the concept of "anywhere, anytime learning" (McGill, 2013).

There are a number of mobile learning platforms currently available. These range from smaller sites that use video-based learning (uQualio), virtual classroom environments (Adobe Connect Learning) and micro-learning platforms (Learner Mobile) to fully developed and integrated platforms, such as Code Academy, Coursera, Udemy and Khan Academy.

[15] The difference between e-learning (electronic learning) and m-learning (mobile learning) is that e-learning most often refers to 'tethered' devices, such as intelligent media-rich and hyper-linked desktop devices, while m-learning refers to portable personal devices, such as tables and smartphones (Taxler, 2005).

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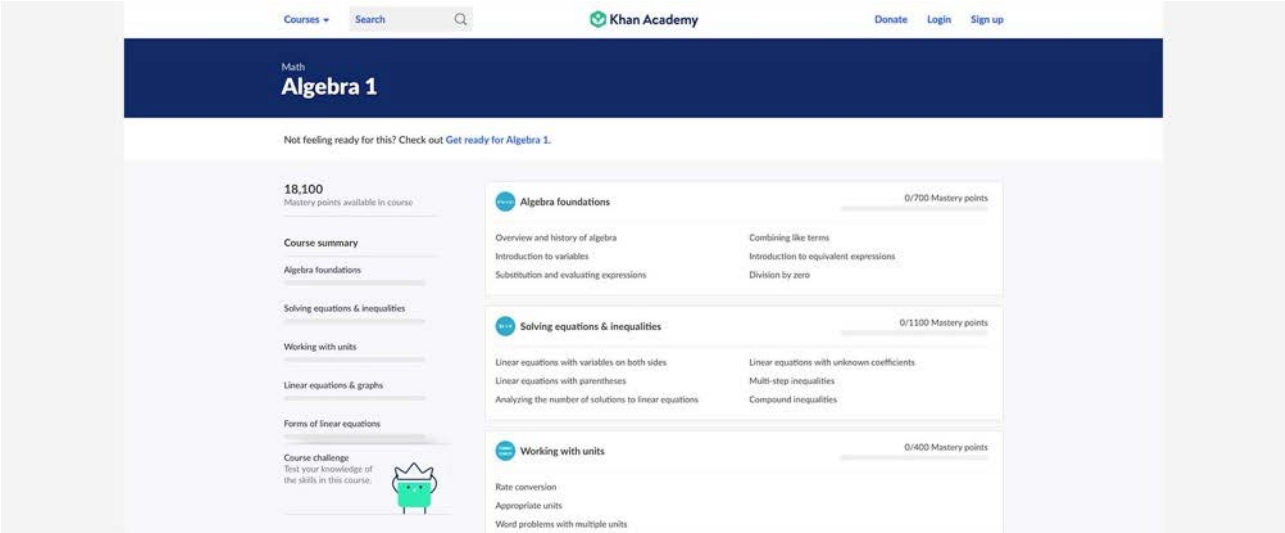

Figure 4: Khan Academy interface (Khan Academy, 2019).

Mobile learning platforms, such as Khan Academy (Figure 4), are designed to allow easy access to information, promote blended learning[16], provide privacy and offer an interactive and collaborative learning experience to the user (Cavus & Uzunboylu, 2009). The level of these elements varies in relation to the limitations of the operating system or within the context in which they need to operate. For example, some platforms, such as Khan Academy, integrate gamification principles to enhance the learning experience through various game-like components, mechanics, and dynamics, as seen by the avatar, badges and narratives in Figure 5:

[16] Blended learning is a mix of traditional classroom instruction (which in itself varies considerably) and instruction mediated by technology, which can be one learner with a tablet or laptop, or small groups of learners working together on devices (Strauss, 2012).

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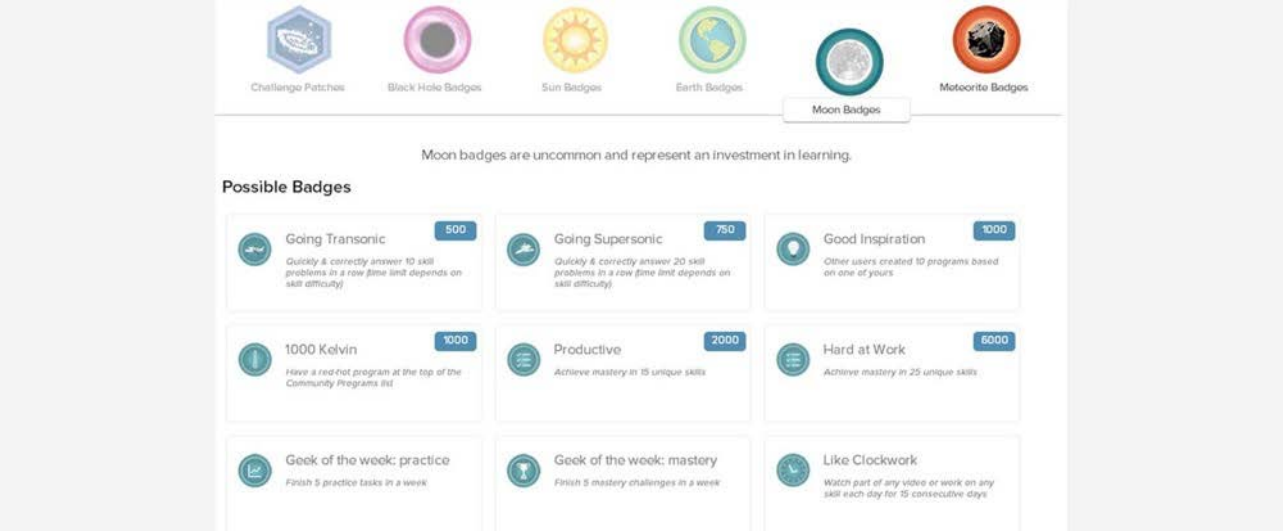

Figure 5: Khan Academy gamification elements (Khan Academy, 2019).

Even though Sharples and Vavoula were of the opinion that “mobile learning is not about the technology, but rather about the learner”, it still creates a hierarchical impression, which conflicts with the flat ontological perspective of this study (2009). It is evident that there is a disconnect between the implementation of ‘off the shelf’[17] technologies from developed countries and the South African context, as seen from the many failed attempts by the government (Kathrada, 2019). Therefore, to meet the aim of this study, it is believed that critical questions surrounding mobile learning needs to be asked within a South African context. This study presents the following six critical research questions, as contextualised in Addendum 4, namely 'Who?', 'What?', 'Why?', 'Where?', 'When?' and 'How?'.

From the outset, the discussion on mobile learning is one with many intertwining threads, which can just as easily be broken by the various social, political, or economic pressures as they can be mended by new developments in information and communication technologies. However, it is clear that the key stakeholders, such as developers, implementers and users, are of equal importance in the process, as the success of mobile learning hangs in the balance between what is being offered (in terms of mobile learning devices and applications) and how the users respond to the offering, as well as how well it operates within the environment it was designed for (Aluko, 2017).

[17] ‘Off the shelf’ is used to describe a product that is available immediately and does not need to be specially made to suit a particular purpose (Cambridge Dictionary, 2019).

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It is evident that one needs to consider both the value of those who develop and implement mobile learning, as well as those who use it. To put this into perspective, *The Guardian* has published a report entitled *How much are you worth to Facebook?* which gives an interesting perspective in terms of the value of the users of technology (Gibbs, 2016). The report, which divided Facebook's quarterly revenue gained from targeted advertising by the number of actives users, estimates the average value of each user is estimated at $3.73 (or approximately R53 at the current exchange rate). This might not seem like a large amount, but when one considers that there are over 1.5-billion active users, the revenue declared for that financial quarter was nearly $6-billion (approximately R85.4-billion at the current exchange rate). This gives an insight into the value and power of the user, which is often underestimated or not considered in the development or implementation of user-based technologies such as mobile learning applications.

The relational dynamic between the developers (technology and software companies who develop mobile learning components and applications), implementers (government departments and private sector initiatives who drive the implementation of mobile learning in schools and other educational institutions), users (teachers and learners), as well as the technology (learning components and applications) reflects that of a flat ontological perspective, which in turn, dovetails well with the theoretical framework of this study. This relationship has existed since the dawn of the technological pursuit, as indicated by Leonard-Barton and Kraus's 1895 paper entitled *Implementing New Technologies*, which was published in the *Harvard Business Review*.

There seems to be a duality in who ultimately needs to benefit from mobile learning. The initial thought is that the learner should benefit first and foremostly, which is still considered to be true. However, as with all supply and demand industries, there also needs to be benefits for developers and implementers. Mobile learning is undoubtedly valuable to the learner, with regards to its accessibility, adaptability, and connectivity, as outlined in the White Paper on the benefits of mobile learning (Lynda, 2015). Nonetheless, the mobile learning industry should also present a valuable and viable pursuit for developers and implementers, so that further progress can be made by means of an appealing market.

South Africa's primary education system is ranked at 126th out of the 138 countries, according to the World Economic Forum's Global Competitiveness Report (2018). As

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mentioned, mobile learning is often seen as a panacea for the social, political, and economic challenges that the education sector is facing. However, a more realistic and unpretentious approach is needed for the introduction of mobile learning if you take into consideration the current state of South African schools is taken into consideration. Rinquest (head of Equal Education in the Eastern Cape) summarised the state of Eastern Cape schools at a panel discussion indicating that “of the 5,000 schools in Eastern Cape, 197 have no water, 53 have no toilets, 2,127 only have pit toilets, and 245 have no electricity” (2017). It is therefore difficult to imagine the ‘paperless classrooms’ and ‘digital school’ concepts advocated by industry and the government, when the true challenges that schools face are at a grassroots and infrastructural level, which would need to be overcome first. In other words, there needs to be a classroom first before there can be a ‘paperless classroom’. Therefore, what is most important is to create a conducive learning environment that motivates and stimulates the learner. This is a solution that would need to adapt to each individual situation with its own unique set of social, political, and economic factors - over and above the additional challenges brought on by the ongoing global COVID-19 pandemic.

Mobile technologies are becoming more embedded, ubiquitous, and networked, with enhanced capabilities for rich social interactions, context awareness and internet connectivity (Lonsdale, Naismith, Sharples & Vavoula, 2012). Such technologies are undoubtably impacting the way we consume information and ultimately the way we learn. The challenge is, however, that mobile technologies advance so rapidly, according to Ally and Prieto-Blazquez, that it necessitates the development of “new educational modules to cater for new generations of learners who will be using mobile technologies that do not yet exist” (2014). This also means that the current educational method (face-to-face classroom-based delivery) is outdated as it was developed before the advent of information and communication technologies which shape existing mobile learning applications. Consequently, Ally and Prieto-Blazquez suggested that “teacher training must be re-invented to prepare teachers for the technology-enhanced educational system[s] of the future” (2014), which has now become an unavoidable reality with the ongoing COVID-19 global pandemic.

Reflecting on the need to consult with all key stakeholders during the design and implementation of mobile learning technologies, Roblyer and Doering noted that “the success of [mobile learning] initiatives could be prejudiced by attempts to use technologies

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in ways that are not meaningful for learners and do not align with learners' motivations and goals" (2010). Therefore, as McGill explained, "understanding what motivates learners to use mobile technologies is an important consideration for [those] wanting to introduce new technologies into learning" (2013). McGill suggested the following main areas of motivation for learners (Figure 6), which relate to the social interactions, entertainment, authoring, the lecturer, mobility, learner productivity, performance outcomes, learning experiences and information access (2013).

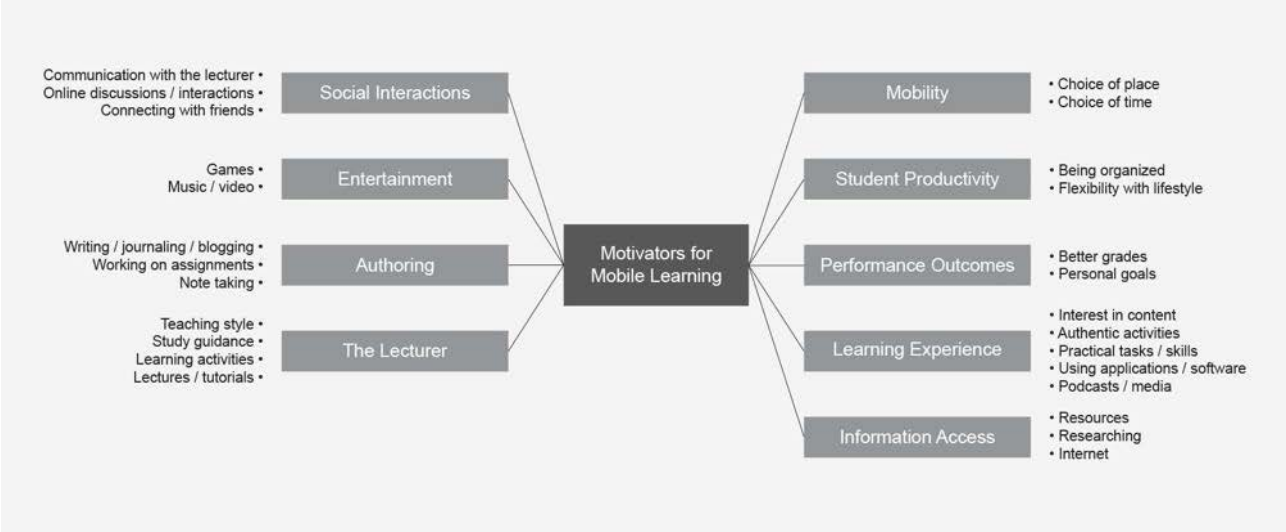

Figure 6: Motivators for Mobile Learning (McGill, 2013).

Reiterating the previously stated need for a conducive learning environment that motivates and stimulates the learner, one would need to localise McGill's study to examine whether the motivators (Figure 6) correspond with those of learners in the South African context. It would be unrealistic to accept, for instance, that an online discussion or interaction serves as a main social motivator for learners at a school without running water, electricity, or toilets. It is true that the need for mobile learning exists as evidenced by the strategies and initiatives by the private industry and government, as listed in the recent State of the Nation Addresses. However, as determined, all key stakeholders should be consulted during this process, especially the intended users, in order for the mobile learning implementations to be effective.

With broadband penetration showing a steep upwards trajectory from 59.7 per cent in 2017 to an estimated 80.8 per cent in 2023 (Figure 7), South Africa is listed as the fastest growing country on the continent in terms of internet usage penetration (Statista, 2019). Despite this

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rapid growth, South Africa still faces challenges with regard to the persistent digital divide[18], where many remote communities are still without access to connectivity owing to demographic and related economic factors (Gillwald, Moyo & Stork, 2012).

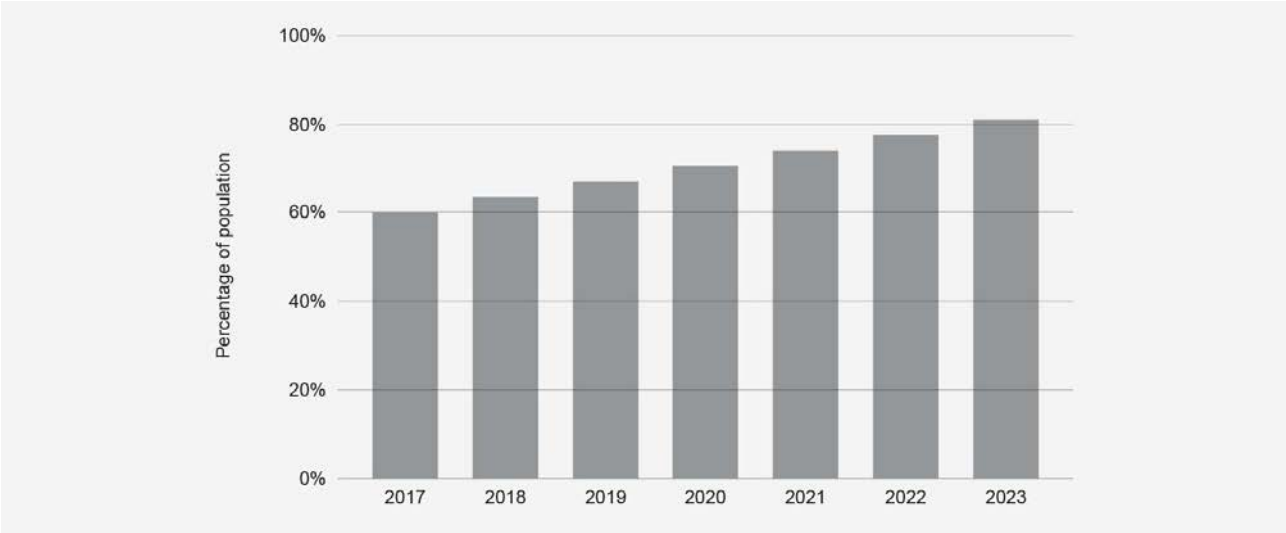

Figure 7: Internet user penetration in South Africa from 2017 to 2023 (Statista, 2019).

In its broadest sense, mobile learning refers to ‘anywhere, anytime learning’, which often relies heavily on access to internet connectivity. Aluko reflected on this by noting that the advancements in information and communication technologies bring new opportunities; however, with South Africa’s current state of education, it can offer both solutions and challenges moving forward (2017). It is evident that not all South African schools have the capacity to integrate information and communication technologies. Nonetheless, the immense drive from the private sector and government to breach the tipping point in connectivity can be seen in “the growing range of mobile offerings, including mobile applications (smartphone apps) and curriculum-supported websites” (Aluko, 2017). This trajectory has evidently been spurred on by the ongoing COVID-19 global pandemic, which has forced a more rapid development and implementation of these offerings[19].

The advancements in information and communication technologies have undoubtedly changed the way learners interact with learning materials and resources; however,

[18] The digital divide refers to the gap between demographics and regions that have access to modern information and communications technology, and those that do not or have restricted access, which include the telephone, television, personal computers and the Internet (Rouse, 2014).

[19] The researcher hereby acknowledges that more accurate and up-to-date data reflecting the influences of the COVID-19 pandemic is continuously being published. However, the research was conducted in a specific timeframe, which was from 2019 - 2021.

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according to scholars, information and communication technologies do not necessarily have “intrinsic benefits but are most usefully understood when they are interwoven into practices that exists in specific contexts and for particular purposes” (Vosloo, 2013). The challenge in the South African context is that even though “mobile technologies have replaced different tools on which learners can learn, such as desktop computers”, many rural schools do not have electricity for such devices (Qualman, 2016).

In contrast to the prosperous economies which can support mobile learning implementations for some countries, such as Ghana, mobile learning initiatives are crucial in the development of literacy. For example, some rural Ghanaian village libraries are now equipped with rudimentary e-readers, “giving the students access to hundreds of books that could never be physically sent to the library” because of the high cost in traditional educational materials (Briggs, 2014). However, there are many more mobile learning initiatives that are making a difference in their respective communities as they are specifically developed to solve contextual learning challenges relevant to those environments.

Biggs (2014) has highlighted five initiatives to demonstrate how contextually sensitive strategies and processes, along with basic technology, can be used to develop solutions that address the shortcomings of a diverse set of affected communities. The first example cited by Biggs (2014) is the Eneza Education project in Kenya (Figure 8), which is a website-based mobile assistant for teachers that gives schools and parents access to digital solutions and tips. Learners can also receive educational content, browse through Wikipedia, and communicate with teachers on the platform. It is important to note that this implementation addresses a wide network, as seen by the inclusion of parental access to the platform, as well as a strategy to onboard and upskill teachers and those who assist with teaching.

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Figure 8: Enza Education website (Enza Education, 2021).

The second example is that of Ustad Mobile (Figure 9), a mobile course creation tool that is developed with an open-source toolkit[20], which has already been used by policewomen in Afghanistan to create literacy courses in local languages. The software is free to download and uses a cloud reporting tool for real-time access. It is important to note that this implementation has decommercialised the process, as it is free to use and offers the ability to customise the tools to suit the specific requirements of the users.

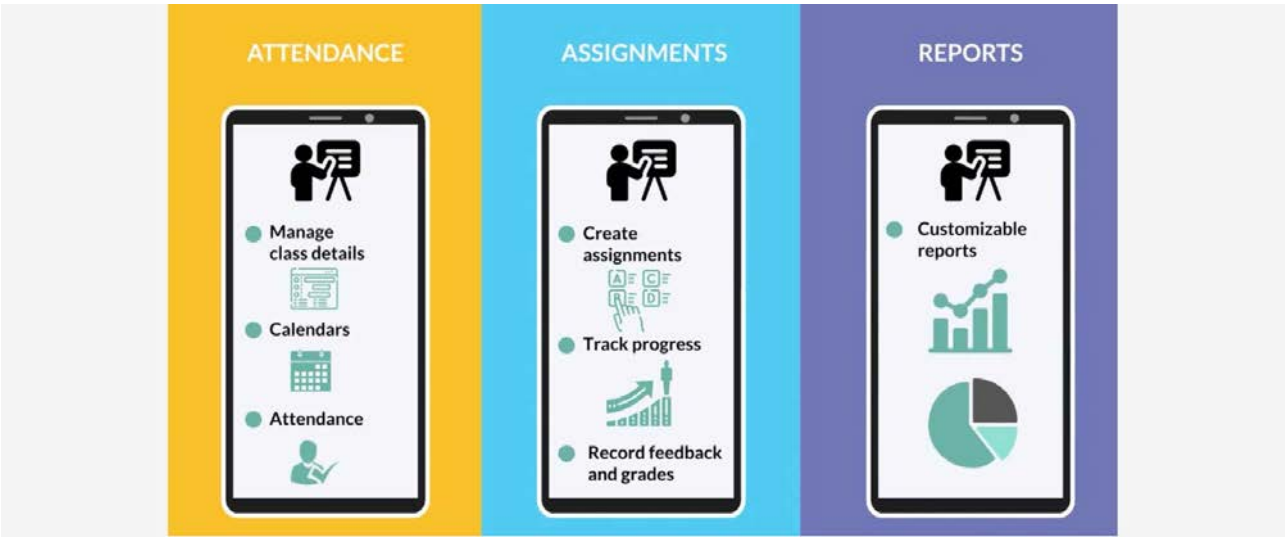

Figure 9: Ustad Mobile application feature overview (Ustad Mobile, 2021).

[20] An open-source toolkit refers to software or digital tools that are openly published and free to use. These usually have a great level of customisation as they are typically created in a collaborative effort and specifically aimed to benefit under-resourced communities (Webopedia, 2010).

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The third example is that of One2Act Mobile Feedback (Figure 10), which is a Norwegian-developed app that uses real-time information from learner devices, allowing teachers to provide rapid and customised feedback to learners. Teachers get an instant snapshot of the learner's understanding of the topic covered, which can be used to increase classroom interaction, group collaboration, and as a springboard for reflection and discussion. It is important to note that this application offers both the teacher and the learner high levels of autonomy and privacy. The teacher has the autonomy to navigate the classroom discussion based on the content overview, which is only available to them, while the learners have both the autonomy and privacy to engage with the course material at their own pace in a more private manner.

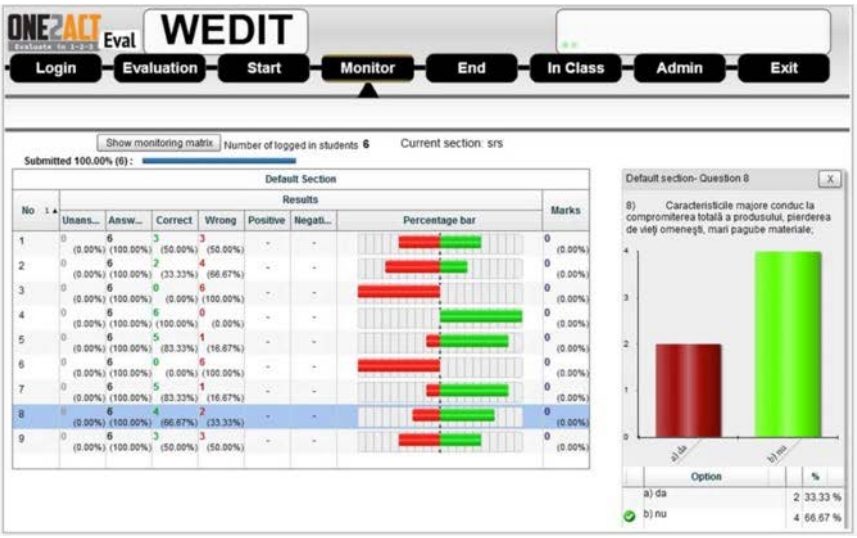

Figure 10: One2Act Mobile Feedback Dashboard (One2Act Mobile, 2021).

The fourth example is that of TBR Mobilization (Figure 11), which is a United States-based app that allows users to create their own 'm-campus'[21] site through the use of social networking and mobile devices. These m-campus sites use digital simulations that feature virtual worlds, learner digital art and augmented reality activations. It is important to note that this implementation also has a high level of autonomy owing to the possibility of creating and customising personal digital environments. However, such an implementation requires a higher level of infrastructure and technology, especially to accommodate features such as augmented reality. This example might, for instance, not be appropriate for implementation at low economic schools.

[21] An 'm-campus' refers to a digital or virtual campus environment that is accessed through a digital platform, such as a website, social media site or mobile application.

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Figure 11: TBR Mobilization virtual biology lesson (TBR Mobilization, 2021).

The last example put forward by Biggs (2015) is that of the OER4Schools Programme (Figure 12), which was launched by the United Kingdom and has been rolled out through the Commonwealth. The program is a digitally based system that has specifically been developed for low-resourced primary schools and provides interactive teaching modules for mathematics and science and includes lesson pacing and effective questioning. It is important to note the contrast between the level of technology used by TBR Mobilization in comparison to that of the OER4School Programme, which reflects the economic base of the school. This provides an example of how implementations need to be viable and appropriate for the environment in which they serve.

Figure 12: OER4Schools Programme, Kenya (OER4Schools, 2021).

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Upon reflecting on these examples, it is noticeable that most implementations are developed with an underpinning in social learning theories, namely Situated Learning, Experimental Learning and Constructivist Learning, as explained by Millwood (2013). This can be seen in the contextual, unrestricted, and collaborative nature of the examples provided, which emphasises the notion that successful mobile learning initiatives and technologies should be developed within the context they are meant to be used in order for the implementations to be effective.

This sentiment is echoed by Brown who gave insight into the application of mobile learning, by stating that it is “not only important to understand contemporary learning theories, but also identify those applications of mobile technologies that contribute to the optimisation of teaching and learning in the new mobile and digital learning environments” (2005). Brown noted that, “traditionally teaching and learning focused on the learner’s mastery of particular identified content”, where teachers were seen as the most significant source of knowledge (2005). However, this dynamic has shifted over the past few decades to a more constructivist approach, where the production of new knowledge is the aim and teachers have become “merely one spectrum of the sources of knowledge and their role is to facilitate learning and to assist learners in producing new knowledge” (Brown, 2005). This shift in the learner-teacher dynamic is partly owing to the “magnitude of information freely available on the internet, [which] far exceeds the quantity of information conveyed by school instruction and text” (Nyiri, 2002). Therefore, as Brown explained, a new type of literacy has emerged that he terms ‘informational navigation’. This refers to the “effective application, integration and manipulation of existing digital information and technology” (2005).

In response to the concept of informational navigation, Brown offered insight into what the new roles for teachers are by stating that teachers and institutions should not only provide content to learners but also focus on how to “enable learners to find, identify, manipulate and evaluate existing knowledge to solve problems and to communicate this knowledge to others” (2005). This role is especially vital within the context of mobile learning. However, with the apparent disconnect between the preparedness of South African schools and the implementation drive from the private sector and government, Aluko presented the following questions, as listed in Table 3, which are directed at both teaching and learning.

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Table 3: Questions to consider for the implementation of mobile technologies in schools (Aluko, 2017).

Questions to Consider for the Implementation of Mobile Technologies in Schools:	
1.	Does the institution demonstrate ongoing efforts to improve the quality of teaching and learning through the implementation of new technologies?
2.	Has the institution conducted a feasibility study to identify the most appropriate type(s) of technology for implementation?
3.	Does the identified technology meet the demands of a cost-effective educational system with a high-value-to-learner rate?
4.	Does the identified technology meet the needs, resources, and capabilities of both the learners and the institution?
5.	Does the technology provide equal educational opportunities for all learners?
6.	Do learners have sufficient access to the technology to use it to its fullest potential?
7.	Does the technology provide a platform for dialogue (two-way communication)?
8.	Are all key stakeholders in support of the adoption of the identified technology?
9.	Is there an on-boarding and integration strategy in place for learners and teachers?
10.	Does the institution have policies in place for the safe and responsible use of new technologies?
11.	Does the institution have a monitoring and evaluation plan in place to assess the impact of the new technology on both the learners and teachers' performances?
12.	What procedures are in place for effective quality assurance?

It is evident, as seen through the many failures by the South African government, that the questions put forward by Aluko (2017) are not considered in the implementation of digital

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and mobile learning in schools. Research by Baker, Dede and Evans (2018), which reported on how to implement mobile learning effectively, echoed the questions put forward by Aluko (2017). Baker, Dede and Evans offered strategies in their research that include “more active forms of pedagogy[22], more authentic and diagnostic assessment and more links between classroom experiences and life” (2018). It seems as though South Africa has fallen victim to what Baker, Dede and Evans called the "mistake in mobile initiatives", which is that most projects consist only of the device acquisition and distribution but offer no integration strategies or long-term planning (2018). With this in mind, Baker, Dede and Evans presented a corresponding list of fundamental questions that needs to be considered during the development and implementation of mobile learning initiatives, as seen in Table 4.

Table 4: Questions to consider for the purposeful planning of mobile device usage in education (Baker, Dede and Evans, 2018).

Questions to consider for the purposeful planning of mobile device usage in education:	
1.	What are the main aims and goals for the implementation of mobile learning technologies at the institution?
2.	Does the learner and/or teacher have prior experience or knowledge of the technology? If so, how can this experience or knowledge be leveraged?
3.	What supplementary materials are available or need to be created to accompany the implementation of the mobile learning technology? Additionally, how will these supplementary materials be delivered to the learner and/or teacher?
4.	What evaluation and measurement strategies are in place to determine the effectiveness of the mobile learning technology?
5.	What are the contextual ‘conditions for success’ that must be met and what strategies are in place for ensuring the sustainability of the initiative after the start-up resources are depleted?

[22] Pedagogy refers to the study of teaching, including the aims of education, educational psychology, scientific theories of learning and to some extent, the philosophy of education (Britannica, 2019).

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7.	How will the parents of the learners and the greater community be included in the planning and development phase and how will it affect them?

The questions proposed by the aforementioned authors in Tables 3 and 4 highlight the lack of strategic planning and development in the government's mobile learning initiatives. Padayachee echoed this statement by noting that “there appears to be a misconception that merely providing technology can transform education; [however], it is clear that the challenge not only lies with how to use the technology but also with how to integrate digital technologies effectively into the curriculum” (2017).

In response to similar shortfalls in the implementation of digital and mobile learning, researchers have developed an assessment model called FRAME (Framework for Rational Analysis of Mobile Education), which is said to be the “first comprehensive theoretical model to describe mobile learning as a process resulting from the convergence of mobile technologies, human learning capacities, and social interactions” (Koole, 2006). The FRAME model, as Koole explained, attempts to evaluate the effectiveness of mobile learning by taking into consideration “contemporary pedagogical issues of information overload, knowledge navigation and collaborative learning” (2006). According to Koole, the FRAME model represents information which “may be internal or external to the learner [and] can be derived from personal, social, technological, or environmental stimuli” (2006).

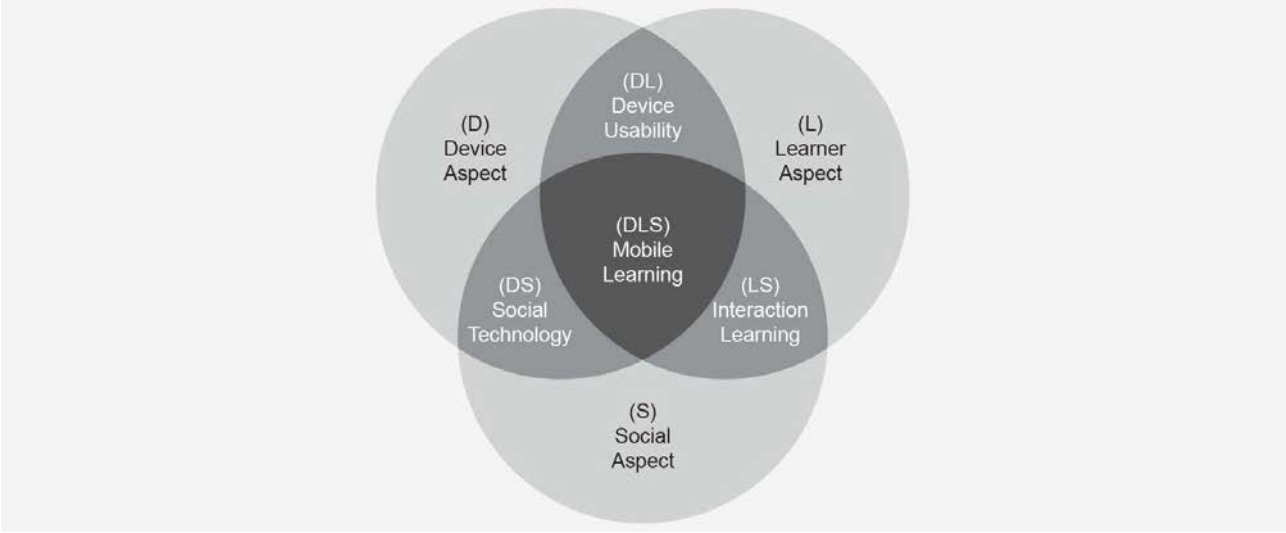

Figure 13: The FRAME Model (Koole, 2006).

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As seen in Figure 13, Koole listed the following three main aspects: ‘Device Aspects’ (which describes the characteristics of the technology), ‘Learner Aspects’ (which describes the characteristics of the learner), and ‘Social Aspects’ (which describes the interaction and environment). Interestingly, as these aspects overlap, new combined aspects are created. 'Device Usability', which is an overlap between the device and learner aspects of mobile learning, refers to aspects such as portability and information availability, as well as the psychological comfort and satisfaction one might experience from using such devices. 'Social Technology', which is an overlap between the device and social aspects of mobile learning, refers to aspects that facilitate networking, connectivity, and collaboration while 'Interaction Learning', which is an overlap between the social and learner aspects of mobile learning, refers to situated cognition resulting from the interaction between learners or learning communities. It is evident that mobile learning, as seen through the perspective of the FRAME model, has a foundation in the theory of sociomaterialism, as seen by the overlapping social and material aspects of the model.

The mobile learning space as seen in Figure 13 is situated central to the main and combined aspects, which in turn reflect both the relational ontological perspective and the theoretical perspective of entanglement in this study. The model strongly suggests that through taking all the different aspects involved in the development of mobile learning (device aspects, learner aspect and social aspects) into consideration, more effective and practical mobile learning devices, appropriate learning materials and effective learning strategies can be developed and implemented in the context they are meant to serve (Koole, 2006).

Vodacom’s Head of Corporate Affairs, Netshitenzhe, recently said at a press conference that Vodacom’s “vision is for the country to move towards ‘one learner, one mobile device’, where we do away with hardcopy textbooks altogether and we digitize the entire curriculum so that it’s accessible anywhere” (2018). This could potentially bring much needed alleviation to the textbook delivery challenges which the government is currently facing. To put this into perspective, according to a report published by The South African National Treasury, it would cost R4.7-billion a year to supply one book per subject to each learner, excluding delivery costs (Pillay, 2018). The astronomical costs of traditional paper textbook delivery methods are undeniably unsustainable and unpractical; therefore, it is essential for the education sector in South Africa to implement mobile learning effectively. Fortunately, South Africa has become an active role player globally and a leader continentally, as seen

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during the 2016 E-Learning Conference in Africa held in Cairo, where more than half of the number of delegates were South African (Ischebeck, 2017). According to Ischebeck, “South Africa is home to some of the continent's most innovative e-learning start-ups, including two young businesses called Obami and Rethink Education” (2017).

As seen by the private sector and government’s commitment to the large-scale implementation of digital and mobile learning, the trajectory of internet usage penetration, as well as South Africa’s position continentally and to some extent globally, it is evident that it is quickly moving towards fully embracing the fourth industrial revolution. The need is pressing, especially during the ongoing COVID-19 global pandemic. Mobile learning technologies are available and adaptable, as seen by the initiatives prospering elsewhere in countries that are in a less economical position than South Africa. Therefore, in terms of ‘When?’, the answer is ‘Now’.

2.4 Participatory Design

To put it succinctly, participatory design is a design methodology in which all key stakeholders are involved in the design process. According to Levinger, participatory design stems from the work done by Scandinavian researchers in the 1970’s, Nyaard and Bergo, and their 'Collective Resources Approach' theories (1998). Even though these theories were developed to mediate between trade unions during the workplace democracy movements at the time, the frameworks and policies have since been adapted to design-related and corporate management fields, with the aim to create solutions that are responsive and appropriate to the practical, emotional and cultural needs of all stakeholders (Brigham, 2005). Ehn (2008) emphasises this shift in the concept of participatory design from a political matter to a practical method and tool by arguing:

> *“Participatory design started from the simple standpoint that those affected by a design should have a say in the design process. This was a political conviction not expecting consensus, but also controversies and conflicts around an emerging design object. Hence, participatory design sided with resource weak stakeholders (typically local trade unions), and developed project strategies for their effective and legitimate participation. A complementary reason for participation, and in the long run probably the strongest motivation for its use in many organizations, was to ensure that existing skills could be made a resource in the design process” (Ehn, 2008).*

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Yeung, Lim and Rahman (2018) explained that participatory design involves participants from a wider network, from “users who are directly affected by the design, to the local business owners who may be peripheral to it, [as well as other] stakeholders with the ability to impact the project” (Yeung, Lim & Rahman, 2018). In response to the aspect of participation in the design process, Emery and Thorstrud contended that participatory design can be seen as a “model for the democratization of technology”, which gives insight into the political and ethical issues of such a design process (1976), as well as how it aligns with this study's sociomaterialistic theoretical framework.

In order to gain a critical understanding of participatory design, especially within the context of South Africa, the subject matter has also been reviewed by the previously mentioned six critical questions (Addendum 4). In their research, Yeung, Lim and Rahman puts forward the following eleven principles for conducting "meaningful and successful research when designing with people" (2018), as seen in Table 5. These principles can offer the researcher a base understanding, or point of departure, in their research design, specifically as viewed through a flat ontological perspective and sociomaterialistic framework.

Table 5: Principles for designing with people (Yeung, Lim and Rahman, 2018).

Principle:		**Description:**
1.	Build professional relationships	It is advised that the process starts with a small manageable group of selected participants.
2.	Leverage off existing networks	One could potentially find a local partner that is already embedded within, and trusted by the community.
3.	Consider the environment	Most people are not familiar with community meetings or workshops and could find the process intimidating. Consider a socially accessible venue, such as a coffee shop.
4.	Make information accessible	It is advised that all theory and information is presented in simplified terms that is fully understood and accessible to all participants.

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5.	Facilitate, not prescribe	Allow participants to create their own solution and engage with those solutions openly and collaboratively.
6.	Enlist neutral facilitators	Facilitators should be objective with no stake in the outcomes of the activity and be on an equal level with the participants.
7.	Test and refine	Prototype early and engage with participants to motivate 'quick wins' with concrete outcomes, while avoiding abstract conversations.
8.	Talk less, do more	Involve participants in a hands-on manner, as some might not be able to articulate their thoughts well.
9.	Do not present a perfect solution	Intentionally create 'gaps' for participants to explore and respond to - as a finished product might communicate that the idea is finalised and cannot be changed.
10.	Promote skills and expertise	Encourage participants to enlist their skills and expertise during the design process.
11.	Build capacity over time	Provide training or resources to further develop the skills and knowledge of participants.

It is evident that the development of mobile learning technologies through a participatory design process affects a much wider network than initially anticipated. Even though mobile learning is undoubtedly aimed at benefiting the end users who are teachers and learners, one must acknowledge how critical the environment surrounding this process is. The opportunities or limitations of the social, political and economic factors in a community or country in particular, need to be considered as these all have an enormous impact on the process. It is therefore crucial that these factors are taken into consideration during the development of the proposed design framework so that the most suitable participants are included.

Stakeholder participation might seem simple; however Asaro explained that there are a number of challenges that can occur during the engagement process (2000). These

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challengers often relate to the political, hierarchal or intellectual differences among stakeholders. For example, according to Asaro, in some instances workplace politics can "impinge on the process to the extent that managers may resist the participation of low-level workers, or intimidate them in the meetings, or act to discount their authority, skill, and knowledge" (2000). In order to mitigate these challenges, Rahman, Lim and Yeung (2018), noted that a successful participatory design process depends on three key areas, namely the adherence to core design principles, an appropriate design process, and the application of the most suitable tools and methods. With this in mind, one might view the role of the designer during the process of participatory design to be that of a facilitator whose goal is to provide the guidelines (core design principles[23]), platform (participatory design process) and instrument (methods and tools[24]) that enable the democratic input of all relevant stakeholders. Sanoff (2006) summarised the most fundamental benefits of the participatory design process, as presented in Table 6:

Table 6: Fundamental benefits of participatory design (Sanoff, 2006).

Fundamental Benefits of Participatory Design:	
The participatory design process allows for the ...	
1.	... improvement in the quality of decisions;
2.	... minimisation of costs and delays;
3.	... increased ease of implementation;
4.	... avoidance of 'worse-case' confrontations;
5.	... maintenance of credibility and legitimacy;
6.	... anticipation of public concerns and attitudes; and
7.	... development of public expertise and creativity.

[23] The core design principles of the participatory design process for IT-related projects include collaboration, genuine user participation and anchoring visions (Robertson & Simonsen, 2013).

[24] The methods and tools used in a participatory design process can include interviews, workshops, observations etc. (Robertson & Simonsen, 2013).

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The fundamental benefits put forward by Sanoff (2006) are directly aligned with some of the challenges facing South African education. It is believed that there is the potential to improve the development of digital and mobile learning by aligning initiatives to such fundamentals. For example, the current attempts at the implementation of digital and mobile learning in South African schools can benefit from a strategy which promotes quality, minimises time and cost factors, optimises actions, mitigates risks and maintain credible democratic processes, while creating an environment that builds public expertise.

Even though participatory design has its strengths, it is not without its challenges and limitations. Muller (2002) noted that the participatory design process can be chaotic and fragmented as the researcher needs to collect data through the implementation of numerous exploration, discovery and prototyping strategies. Muller (2002) further explained that because participants might not be designers themselves who understand the design and technical aspects of the end product, it might not be possible to integrate all of their comments and contributions. Furthermore, such a process can also limit the research to remain a human-centred approach, if the research is not objectively viewed. In some instances, the revelation by Beyer and Holtzblatt (1998), who initially argued that participatory design might not lend itself well to "radical change development, which is often necessary for new system designs", still remains a challenge when confronted with a design 'problem' that is limited by the existence and accessibility of the technology of the time.

Interestingly enough, throughout the preliminary investigation of this study, cultural and language differences, or rather the barrier that these can create, are often cited as a disadvantage with regard to the participatory design process. Yet it is the opinion of the researcher that the proposed participatory design process can only benefit from the diversity of its participants, especially as this study is based within the context of South Africa and requires sensitivity to these differences. Therefore, it is believed that the access to cultural and language differences, which a participatory design process can facilitate, is considered to be an advantage. The proposed framework for designing mobile learning experiences would need to cater for these differences, which are widely prevalent in South Africa. It is therefore determined that the most important aspect of participatory design is the diversity in the inputs and viewpoints of all stakeholders. It is believed to be crucial that the participatory design process remains sensitive to the social, cultural and political elements within the South African context.

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During the early establishment of participatory design, in relation to its purpose in the field of design, Banham noted that "Why do we want [...] assistance in planning our cities, in designing our products? The answer is because we are not at all certain what we are about and how we should be about it" (1971). Even though the application of the participatory design process has expanded since its inception during the 1970's, the core principles as put forward by Luck (2018) in Table 7, are still applicable and underline why it exists and why it remains a valuable research method.

Table 7: Core principles of participatory design (Luck, 2018).

Core Principle:		**Description:**
1.	Equalising power relations	Finding ways to give voice to those who may be invisible or weaker in organisational or community power structures in which they are imbedded in.
2.	Situation-based actions	Working directly with people and their representatives in their workplace, homes or public areas to understand actions and technologies in actual settings rather than through formal abstractions.
3.	Mutual learning	Encouraging and enhancing the understanding of different participants by finding common ground and ways of working together.
4.	Tools and techniques	Methods that can help different participants express their needs and visions.
5.	Alternative visions about technology	Ideas that can generate expression in equality, whether it be in the workplace, at home, in public or elsewhere.
6.	Democratic practices	Putting into play the practices and role models for equality amongst those who represent others.

The core principles put forward by Luck (2018) in the above Table 7, echo the flat ontological perspective of the overarching theoretical framework (the theory of sociomaterialism) of this

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research. The methodology of participatory design also aligns itself with the flattened approach of the aforementioned theoretical framework, as it "emphasizes co-research and co-design [where] research-designers must come to conclusions in conjunction with users" (Spinuzzi, 2005). It is important to note that these principles promote a democratic process that is not human-centred, as it also included interaction between non-human elements, but reflects Deleuze and Guatttari's concept of an 'assemblage' (1988). Bryant (2006) described this concept by stating:

> *Assemblages are composed of heterogeneous elements or objects that enter into relations with one another. These objects are not all of the same type. Thus you have physical objects, happenings, events, and so on, but you also have signs, utterances, and so on. While there are assemblages that are composed entirely of bodies, there are no assemblages composed entirely of signs and utterances*.

In terms of the core principles of participatory design, as put forward by Luck (2018), and the concept of an 'assemblage', as described by Bryant (2006), one can observe how the relationships between and amongst the stakeholders (the learner, teacher, school, department), the learning experience (digital and mobile learning devices, platforms and processes), as well as the environment (the social aspects of the school and home environment) are created and how they 'interact'. These interactions can be observed throughout the research design process, which is loosely structured by Spinuzzi (2005) in three stages, namely the exploration stage, the discovery stage and the prototyping stage. In the exploration stage, the researchers meets with the participants, familiarises them with the research topic and establishes ways in which they can work together. These can include the technologies used, workflows to be implemented and data to be gathered. The exploration stage also includes ethnographical methods such as observations, interviews and examinations which are orientated towards research exploration. In the discovery stage, the researcher and participants engage more interactively through group activities, which are more inclusive and intrusive compared to the exploration stage. The main goal of the discovery stage is to interpret and evaluate the work co-operatively, rather than simply describing it. Engagement methods include, but are not limited to, games, toolkits, workshops, storyboarding and modelling. In the prototyping stage the researcher, along with the participants, develops models, systems or artefacts based on the findings of stages 1 and 2 (exploration and discovery). The prototypes can include, but are not limited to, mock-

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ups, paper prototypes, digital prototypes or any other visual or physical representation of the proposal.

Spinuzzi emphasised that these "stages can be (and usually should be) iterated several times [to provide] an iterative co-exploration by designers and users" (2005), which is believed to be a key strategy in the establishment and refinement of the proposed framework for designing mobile learning experiences. These experiences are yet undetermined, but can include websites, microsites and mobile applications. Tironi was of the opinion that prototyping should facilitate a process which activates the emergence of issues "instead of pre-defining them or taking them for granted", as the process of "prototyping plays a fundamental role as an experimental space in which to engage with possible worlds and the speculative figure of what-if" (2018). With the number of unknown social, political and environmental factors at hand, along with the commitment to avoid assumptions, it is critical that the research is led by an unbiased process that can facilitate the emergence of yet unknown possibilities and solutions. Chase explained that "When you understand the people that you are trying to reach, and design from their perspective, not only will you arrive at unexpected answers, but you'll come up with ideas that they'll embrace" (2021).

Therefore, it is believed that prototyping will be central to the participatory design process, as a way to discuss, evaluate, and refine. Tironi further explains that the process of prototyping moves towards "more experimental modes of 'drawing things together' [while] considering the entanglement and assemblage between humans and non-human agencies" (Hillgren, Seravalli & Emilson, 2011), which directly reflects on the sociomaterialistic perspective of the research. However, according to Tironi, "it is important to underscore a distinction between prototype as object[25] and prototyping as a performative activity[26]" (2018). The latter refers to the third stage of participatory design, as put forward by Spinuzzi in Table 13. This differentiation between the object and process is echoed by Hillgren, Seravalli and Emilson, who referred to the prototyping as "thinging", as it does not only entail the object (thing) itself, but also includes the process, which takes into consideration the relevant sociomaterial relationships and deals with issues "side by side, instead of

[25] The term 'prototype as object', refers to the physical or digital asset that is being created e.g., smartphone or mobile application.

[26] The term 'prototype as a performative activity' refers to the process of developing and refining the prototype object. This process can be a participatory design process.

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negotiating them through consensus" (2011). Keshavarz and Maze (2013) explained that a pitfall in the participatory design processes is to achieve consensus amongst the participants as consensus can suppress the "contestatory nature of common life" and reduce "subjectivization to rational debate among parts of a community" (2013). The aforementioned authors therefore put forward a design process that is based on dissensus, which avoids the formal processes of research, such as participant selection, research approach and research methods. This process can, to some extent, prevent dissensus "as presuppositions about subjectivity govern the selection, terms and means of engagement for participation" (Keshavarz & Maze, 2013).

To reflect on Spinuzzi's statement that "research-designers must come to conclusions in conjunction with users" (2005), it is evident that the users (who are the learners and teachers) are most affected by the outcomes of a design process, which is aimed at the development of mobile learning experiences. Moreover, a participatory design process will predictably reveal the limitations, opportunities and overarching environmental factors (social, political and economic) which may not be evident to the end user who, under normal circumstances, will not be privy to the reasons behind the design choices made.

Smith and Iverson explained that participatory design is not only limited to the co-designing aimed at a mutual outcome, "but [is] also about a different type of scoping and scaling of multiple and possible directions for sustainable change within larger ecologies of social transformation" (2018). It is therefore believed that the main need for the implementation of a collaborative design process, such as participatory design, is to facilitate a process that is not only sensitive to the environmental factors, but also provides a mechanism for all key stakeholders to take ownership and adopt the outcomes in their various fields. This in turn, creates a multiplicity in the impacts of the outcome.

Dalsgaard (2012) explained that, since its first introduction, the participatory design has grown to become an established field of practice and research. The methods and techniques of participatory design can be seen to be "employed in a range of projects, spanning from software development to urban planning" (Dalsgaard, 2012). This gives insight into the boundaryless nature of the process, in terms of project scale and complexity. Gärtner and Wagner (1996) established three categories or 'arenas' in an attempt to contextualise the scale and complexities of participatory design within their research specifically for the

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organisational implementations of computer systems. The first arena, according to Gärtner and Wagner (1996) is the Individual Project Arena, which refers to a project area where specific systems are designed and new organisational forms are created. The second arena, the Company Arena, refers to a project area where violations of agreements are diagnosed and stable patterns of organisational functioning are questioned and redesigned. Lastly, the National Arena refers to a project area where the legal and political framework is negotiated, which defines the relations between various industrial partners and set norms for a whole range of work-related issues.

Gärtner and Wagner's categories or arenas are, however, structured as a hierarchical process that starts on a project scale and expands to a company scale and eventually to a national scale or beyond. Therefore this process does therefore not align well with the overarching theoretical framework of the thesis and needs to adapt to an flat ontological perspective in which issues related to the project (the Individual Project Arena), school / community / province (the Company Arena) and country (the National Arena) are all considered equally to ensure that the research and development process remains sensitive to the complexities of the South African context.

Smith and Iverson explained that a paradox exists in contemporary participatory design, by noting that the increased acceptance of participation in general design discourse has led to a "diluted meaning of participation" (2018). It is therefore important to emphasise the difference between 'participation' as the mere involvement of stakeholders and 'participatory design' which, according to Halskov and Hasen (2015), relates specifically to the core approach of the research process. As a researcher, it is important to establish the understanding of this difference at the outset, as it can have a critical impact on the outcome of the research. Lundmark and Lymer explained that participation can offer an opportunity for "people [who are] untrained in design practices to take part in something that enables them to contribute to the making of something of value to others" (2016). However, it is the opinion of the researcher that the mere involvement of participants, especially those 'untrained' (untrained in terms of individuals who do not have any expertise or experience in the subject matter and therefore cannot contribute meaningfully to the design process) participants, will not necessarily improve the results. However, as Manzini (2014) maintained, processes that are led by experts, most often result in a top-down approach, as compared to processes that are led by non-experts (mainly communities) which most often

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resulting in bottom-up approaches. Even though non-experts can provide insights that could spark informative discussions amongst experts, Henry Ford's famous quote comes to mind in relation to the participation of untrained individuals; "If I had asked people what they wanted, they would have said faster horses[27]".

In an attempt to define participatory design as a core approach of the research process, Halskov and Hasen (2015) advanced the following three approaches which attempt to address how participatory design can be implemented. The first approach includes an implicit understanding of participation, in which participants are involved, but their role and function are not explicitly stated. The second approach is the understanding of participation in terms of being full participants in the design process and providing a user's point of view. The final approach, as put forward by Halskov and Hasen (2015), is a view of participation focussing on mutual learning and knowledge transfer between the users and designers involved. Even though Halskov and Hasen listed three distinct approaches to the participatory design process, a hybrid of these approaches is most often required to attain the full potential of such a process. The following hybrid approach is therefore suggested by the researcher:

> *A collaborative process that allows participants with a diverse set of expertise and experience to collectively and authentically conceptualise, develop, test and refine a 'product'[28] or experience, which in turn, results in the transference of skills and knowledge amongst the participants involved (Erasmus, 2021).*

To place the above approach in context, specifically with regards to the authenticity of the participation, Robertson and Simonsen maintained that the process is most genuine when participants are "working as themselves, with themselves and for the task and the project" (2013). Lin and Simonsen (2017) elaborated on this statement by giving insight into the aforementioned three characteristics by explaining that participation 'as themselves' refers to participants who act within their own knowledge and experience and do not pretend to be informed on a particular topic if they are not. Participation 'with themselves' refers to participants who are attentive and present in terms of engaging with the project without distractions. More recently, according to Lin and Simonsen (2017) explain, participation 'for

[27] Although commonly attributed, Vlaskovits (2011) states that there exists no concrete evidence that Ford ever said this phrase.

[28] The word 'product' can be replaced by the intended end result (software, mobile app, mobile device etc.), which in this case is a framework for designing mobile learning experiences.

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the task on the project', refers to participation that is focused on the objectives of the process and contributes towards achieving the shared and agreed-upon goals of the design project.

Jarke and Maaß (2018) contended that one method of engaging with participants is through the use of 'probes', which is a concept that was developed by researchers Boehner and Graber in 2012. Probes aim to "collect ideas for creative solutions" by means of observations, written documentation and photographic documentation, done by the participants themselves in order to "reflect and comment on their own everyday life over a period of time" (Jarke & Maaß, 2018). The strategy of participant self-documentation, according to Boehner and Grabler, along with further interviews and group discussions on the data gathered, can assist researchers with investigating the participants' own observations and comments in an authentic manner that is not unintentionally led by the researcher or guided by the environmental or situational factors of a dedicated participatory design engagement (2012).

Jarke and Maaß explain that the concept of 'probes' has developed over time and in line with technology to include concepts such as 'design probes'[29], 'technology probes'[30] and 'mobile probes'[31], which all anchor around the participatory design process. These modern probes, which take the form of tasks and tools, require a design process of their own. Lee explained that researchers need to "carefully design tasks and tools [...] to fit the project aim, package them and deliver them to users" in a way takes into consideration the context in which they will be used (2019). An example of a multi-probe approach can be seen in a case study conducted by Thoring, Luippold and Mueller (2013) in which the researchers developed, distributed and analysed a collection of probes that were used to conduct research, as seen in Figure 14:

[29] Design probes are defined as user-centred methods with a "focus on the close involvement of users" in the design process (Ronnberg, 2018).

[30] Technology probes are defined as "simple, flexible, adaptable technologies" with the goal of "collecting data about the use of technology in a real-world setting" (Hutchinson, 2003).

[31] Mobile probes are defined as "digital user study tools" which can be used to develop contextual and dynamic self-documented data for "studying people's actions on mobile contexts (Hulkko, Mattelmaki, Virtanen & Keinonen, 2004).

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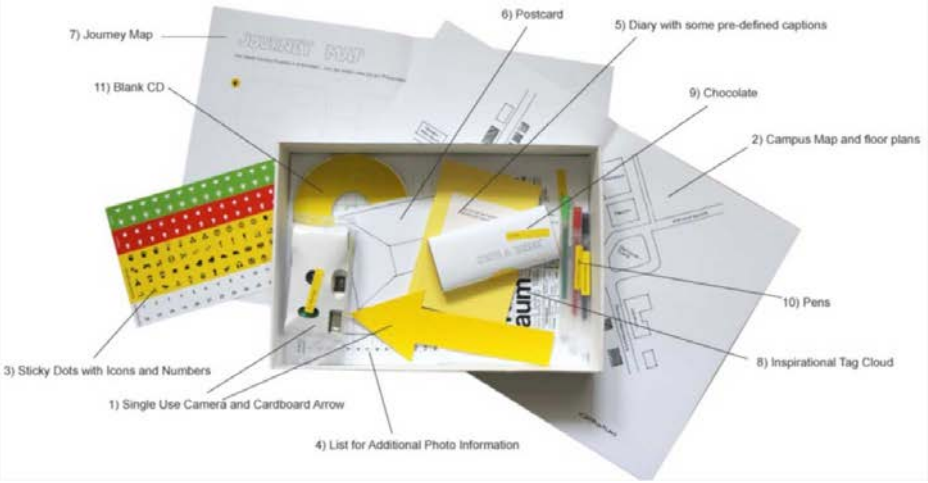

Figure 14: Opening the cultural probes box (Thoring, Luippold & Mueller, 2013)

A summarised analysis of the probes used in the study by Thoring, Luippold and Mueller (2013) has been included in Addendum 5. From this analysis, which highlights both the successes and failures of the probes, it is evident that probes can assist both the researcher and research participants by offering methods and cues to facilitate a more conducive workshop-like process, which in turn can improve the overall research process. Interestingly, as seen in the diversity of the probes and probing methods, a research process such as this responds well to the overarching theoretical framework of sociomaterialism. It also blurs the boundaries and removes the hierarchy between the interactions (social aspects) and tools of interaction (material aspects).

As an overview of how the participatory design process fits within the sphere of research design approaches, Sanders (2008) advanced a diagram (Figure 15) which attempts to illustrate its placement in relation to a design-led approach, a research-led approach, an expert mindset approach and a participatory mindset approach. It is noteworthy that the participatory design process only touches on user-centred design and user-lead innovation, while being heavily influenced by generative design research.

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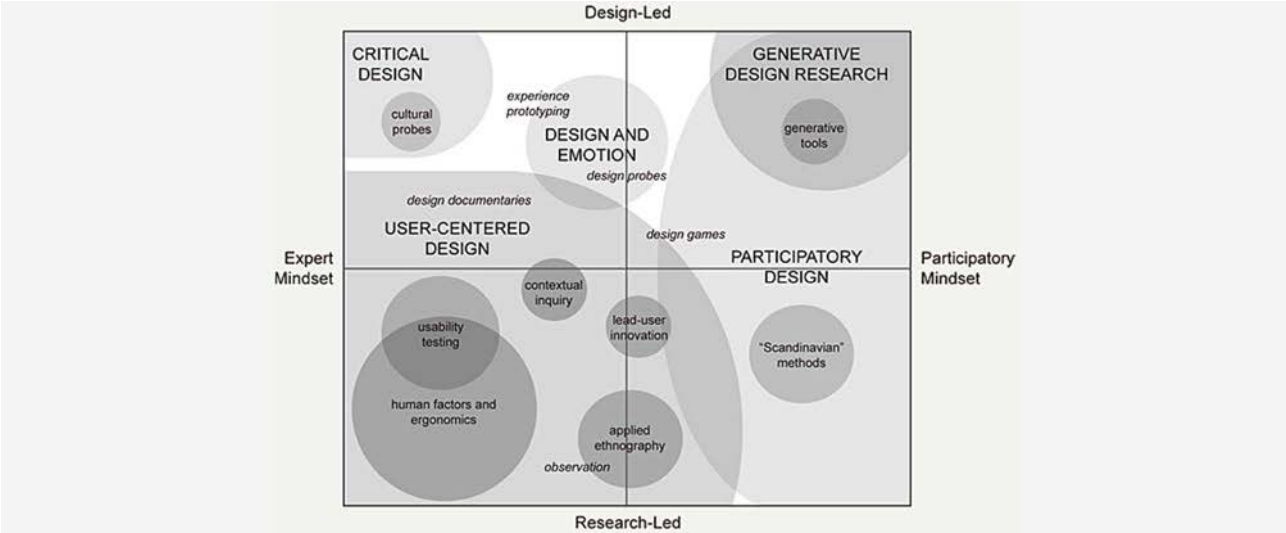

Figure 15: Design research and practice topography (Sanders, 2008)

Participatory design can be implemented at any point, according to Moyers (2018). However, Ciplan (2019) suggested the following three broad guidelines which can be helpful to determine the feasibility of a participatory design process. The first of these guidelines, according to Ciplan, explain that one of the most suitable times to implement a participatory design process is "when a researcher wants to understand how different people think about a given problem, discipline or technology" (2019). The second most suitable time is "when a researcher suspects that what people 'do' and 'say they do' are not the same", and lastly, "when a researcher suspects that there might be a cultural or political disconnect between them and the end-users" (Ciplan, 2019).

Furthermore, participatory design offers a research approach that dovetails both method and methodology. The methods of participatory design, which consists of "all the techniques, strategies, and tools employed by the researcher" aligns well with the methodology of participation in design, as it allows the researcher to "validate a study's rigor to acquire new information" (Bhosale, 2021). It is evident that participatory design does not merely bring people together, but affords the researcher an opportunity to observe a process of interaction between human and non-human participants in a credible, valid and reliable way (Bhosale, 2021). The consideration of the entanglement of the material and social aspects (sociomaterialism), is a critical perspective because as mentioned, “to be is to be related” (Mol, 2002).

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Chapter 3: Methodology

To ensure that the research aimed at developing a framework for designing South African mobile learning experiences is academically aligned, one needs to clearly define the perspectives (research paradigm), the participants (research sample), the process (research design), and the underlying parameters (research ethics) clearly.

3.1 Research Paradigm

The research in its broadest sense (from an epistemological perspective) is positioned to define knowledge as being relative and "developed by people through experiences" (Lyon, 2016). From this perspective (within this specific study) knowledge is considered to be relational and changing.

The guiding factor for both the theoretical research and the participatory design process of this study (the ontological perspective), has also been positioned as relational or 'flat'[32]. This attempts to remove the hierarchical structures or denotations of importance between the various elements found in this study. This position also reflects on the concept of relationality found in the main areas of the theoretical research, sociomaterialism (the social and material aspects are of equal importance), mobile learning (the hardware, software, content, and user have equal value) and participatory design (the inputs of all participants are evaluated equally).

The aims of the research outcomes (the research axiology) can be described as sympathetic to the current state of South African education. It is believed that the result of this research (a framework to design South African mobile learning experiences) can potentially help to provide solutions to the challenges facing the South African Department of Education in their attempts to implement digital and mobile learning in schools. This will in turn potentially provide easier access to education for future generations and provide suitable learning platforms and content which can be relevant and meaningful to those who use them. Therefore, the researcher feels morally obligated to utilise this opportunity to do so.

[32] Flat ontology is an approach that attempts to break down classificatory schema, particularly those forms of classification that result in hierarchical or binary modes of thinking (Martson, Woodward & Jones, 2007).

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3.2 Research Sample

The research sample consists of a group of participants (teachers and industry professionals) who were identified through a previous study[33] by the researcher through a method of 'purposeful sampling'. This sampling method, also known as judgement, selective or subjective sampling, relies on the researcher's own judgement when choosing participants (BRM, 2021). These participants are believed to have the knowledge and expertise to contribute meaningfully to the design of a framework for the development of South African mobile learning experiences. The intent was to include learners in the research study; however, it was unfortunately not possible owing to the shifting school deadlines and pressures on learners as a result of the COVID-19 pandemic lockdowns in South Africa. The participant selection process was also guided by the eleven principles put forward by Yeung, Lim and Rahman for conducting "meaningful and successful research when designing with people" (2018) (also seen in Table 5).

Even though the participants were selected based on their skills and experience, Lundmark and Lymer, noted that it is of particular interest to observe "how new roles emerge for the stakeholders in the design project and in the project group during the project's lifespan" (2016). This gives insight into the transformative nature of the participatory design process and, according to Lundmark and Lymer, can lead to "blurred boundaries between design, developers and users" (2016). However, it is crucial that, even if these roles do blur, the act of participation remains authentic. The selected research participants are listed in Table 8, along with an accompanying motivation for each participant. It should be noted that their informed consent to participate in the research was obtained and all protocols associated with the research ethics, as approved by the Stellenbosch University's Research Ethics Committee (Addendum 1), were strictly followed.

Table 8. List of research participants.

No:	Participant:	Motivation:
1.	Secondary School Teacher	Participant-1 has in-depth experience in mobile learning applications, which they have implemented in two

[33] Erasmus, R. (2018). An investigation of the deficiencies in gamified mobile learning in three South African secondary schools in Nelson Mandela Bay. Stellenbosch University. South Africa.

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	(Code: Participant-1)	economically and socio-politically diverse secondary schools in Nelson Mandela Bay. Their experience could offer valuable insights during the development of the framework for designing mobile learning experiences.
2.	Secondary School Teacher *(Code: Participant-2)*	Participant-2, who has less experience in using mobile learning applications as a teaching tool, has been selected as a counterpart to Participant-1. By not having used mobile learning applications in the classroom to their fullest extent, Participant-2 could potentially offer un-biased insights during the development of the framework for designing mobile learning experiences. Participant-2 has a history of working economically and socio-politically diverse schools.
3.	Software Systems Analysist *(Code: Participant-3)*	Participant-3 is a senior software analyst who has worked on a number of educational and learning-based software projects for both the public and private sectors. This experience in systems wire-framing and systems design could be of great value in the development of the framework for designing mobile learning experiences.
4.	Software Developer *(Code: Participant-4)*	Participant-4 is a senior software developer who has worked on a number of educational and learning-based software projects for both the public and private sectors. This knowledge in software development and software design (User Experience and User Interface) could be valuable in the development of the framework for designing mobile learning experiences.
5.	Software Systems Facilitator *(Code: Participant-5)*	Participant-5 is a facilitator who has experience in training individuals with varying degrees of computer literacy in the use educational-based of software solutions. These facilitation and training strategies could give valuable

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		insights during the development of the framework for designing mobile learning experiences.

3.2 Research Design

A participatory design process, according to Robertson and Simonsen, "recognizes the accountability of design to the worlds it creates and the lives of those who inhabit them" (2013). Additionally, such a process, which takes into consideration the input from relevant stakeholders, can offer results that are "more likely to be flexible and robust in use; accessible to more people; more easily appropriated into changing situations; and more adaptable to these situations over time" (Robertson & Simonsen, 2013). This process will allow for a method that is sensitive to the various environmental factors (social, political, and economic) at play, as well as taking into consideration the inputs from the key stakeholders.

The research participants were invited (Addendum 6) to participate in individual 30-minute discussions on the topic of mobile learning. This was done to assess whether their inputs would be valuable for further research engagements. It is important to note that all research participants gave their written consent for all information gathered during the individual discussions to be used by the researcher with no limitation (Addendum 7). The individual discussions were led by the following five questions suggested by the researcher and listed in Table 9.

Table 9: Individual research engagement questions.

No:	Question:
1.	Do you think mobile learning solutions can have value in the current South African educational context?
2.	Based on your experience and expertise, what opportunities and possibilities are available to improve the implementation of mobile learning technologies in schools?

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3.	Based on your experience and expertise, what barriers or challenges work against the implementation of mobile learning technologies in South African schools?
4.	Based on your experience and expertise, what are the key factors to consider when developing a framework for designing mobile learning experiences for South African schools?
5.	From your perspective, do you have any suggestions to improve the current mobile learning experiences used in South African schools?

The individual participant responses to the questions listed in Table 9 were documented (Addendum 8) and analysed in Chapter 4.3 Participatory Design Engagements. After the conclusion of the individual discussions (five in total), the research participants were each asked to each provide three research probes relevant to mobile learning in South Africa from their perspectives, based on the previous discussion points (Addendum 9). The research participants had complete freedom in the selection of their research probes, which could include (were not limited to) news articles, photographs, video clips, audio recordings, voice notes, written observations and illustrations. These research probes will be analysed in Chapter 4.3 Participatory Design Engagements.

These research probes, along with the data gathered in the individual discussions, formed the primary points of departure in the succeeding collective engagement, which took the form of a participatory design engagement. The research participants were invited (Addendum 10) to participate in a two-hour participatory design engagement, which was divided into eight activities with a 15-minute time allocation for each activity. The aim of this structure was to facilitate a collaborative process, while still maintaining a productive workflow and engagement deadline. The structure of the participatory design engagement and descriptions of each activity are depicted in Table 10.

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Table 10: Participatory design engagement schedule.

Activity:	Description:	Aim:	Time:
Activity 1:	Pre-engagement interviews with individual participants	Aimed to obtain an insight into the perceptions about the participatory design engagement. These insights can then be compared to the post-engagement interviews	15min
Activity 2:	Individuals to share a personal experience of mobile learning	Aimed to establish the material and social elements from personal experiences or collective knowledge	15min
Activity 3:	Depict the material and social elements in a diagram while considering their relevance or importance to the other elements	Aimed to break down the perceived hierarchical structure and establish a more relational structure through the use of space and proximity. This process can also reflect the flat ontological perspective of the study	15min
Activity 4:	Break		15min
Halfway - First hour of engagement completed			
Activity 5:	Expand on the material and social aspects with specific reflection on the South African context	Aimed to contextualise the placed aspects of mobile learning to the South African environment	15min
Activity 6:	Link and group elements, both material and social, within the South African context	Aimed to demonstrate the state of entanglements among elements in support of the theoretical framework (sociomaterialism) and reflect the flat ontological perspective	15min

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Activity 7:	Respond to the diagram in terms of identifiable challenges, opportunities and solutions	Aimed to gain insight into the possible structure of the design framework for mobile learning.	15min
Activity 8:	Post-engagement interviews with the individual participants.	Aimed to compare the participants' initial perceptions about the participatory design engagement, with their post-engagement understanding	15min
End - Second hour of engagement completed			

The participatory design engagement, which was recorded digitally, will be analysed in Chapter 4.3 Participatory Design Engagements.

3.4 Research Ethics

According to the Stellenbosch University's Policy for Responsible Research Conduct, all ethical considerations have been met, as outlined in the application to the Stellenbosch University's Research Ethics Committee (Addendum 1). In summary, the individual and participatory engagements gathered no personal or private information from the participants and no data was used or kept without their full consent. Approval to conduct research in the Eastern Cape was formally granted by the Eastern Cape's Provincial Department of Education (Addendum 2).

The participants, whose identities have been protected, were engaged through directed dialogue, conversation, and collaborative practical activities in a workshop-like environment. These interactions with participants have been documented by means of photography and/or videography. All recordings and data have remained securely stored and only the researcher has access to them.

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Chapter 4: Research Through Participation

It is important to establish the delimitations of this study in order to contextualise it as the key stakeholders can change and scale in relation to the study parameters. The preliminary investigation, along with the culminating research, was conducted in Nelson Mandela Bay, Eastern Cape, South Africa. The research is therefore geographically delimited to the Nelson Mandela Bay area and delimited to the experience and expertise of the selected research participants as listed in Table 9.

4.1 Analysis of Participatory Design Engagements

As mentioned, the research consisted of individual interviews, an analysis of the research probes submitted by the participants, and a participatory design engagement. An analysis of the data gathered in these three engagements follows below.

4.1.1 Analysis of Individual Interviews

The responses during the individual interviews (Addendum 8) show an overwhelming agreement that mobile and digital learning can hold value in the current South African educational context. It is evident that this notion has gained more support owing to the limitations in face-to-face learning brought on by the global COVID-19 pandemic. The digital shift also gives digital education the potential to reach learners more effectively and more economically, without any restrictions, if the infrastructure and supporting systems are in place. Unfortunately, as mentioned, the South African educational system still faces challenges at a grassroots level, as seen in the lack of infrastructure (Herman, 2019), hardware and software issues (MyBroadband, 2019) and increased levels of crime (Lesufi, 2019). These all adds to the many layers of challenges one needs to overcome to reach the full potential benefits of mobile and digital learning.

Overall, the participants responded positively towards the implementation of mobile and digital learning in schools and identified a wide range of opportunities and possibilities for the improvement of these implementations from a variety of perspectives. It was interesting to discover the different needs that digital technologies must address based on the different subject matter requirements. Participant-1, who is a secondary school teacher, teaches science and mathematics and requires advanced functionality in the digital software to be able to teach the content of their subjects effectively, which include formulae and drawings.

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Participant-2, also a secondary school teacher, teaches English Language and has noted that the ability to store large amounts of course material on a digital device "has been well received by learners who travel long distances and no longer have to carry heavy books between their homes and school each day" (Participant-2, 2021). The immediacy of e-book delivery can also address the challenges facing paper textbook delivery, which often takes place a few months after the beginning of the school year (Mamokgere, 2019).

The immediacy of digital technologies, as well as instant communication, can benefit teachers who can now engage with learners more effectively. However, it blurs the lines between work time and private time, which has become a concern for teachers. Participant-4, who is a software developer, noted that digital technologies can also provide the opportunity for a unified cloud-based system that can be instantly rolled out nationally instead of duplicated efforts in each province. However, it is recommended that such a system and its content be developed by experts in the field of education and software development to ensure that the best possible and most suitable outcomes are achieved. A critical aspect of such a system, however, is the ability for it to scale according to the individual needs of each school, as there is no single solution for all schools, owing to the differences in infrastructure and resources. Participant-5, who is a software systems trainer, emphasised that the implementation of such a system "should be aimed at assisting and enhancing the work of a teacher, and not at replacing a teacher" (Participant-5, 2021). Nevertheless, the utopian ideal that is being put forward by the government is quickly brought back to reality by the fact is that a large percentage of the teaching staff in South African schools are unqualified and under-resourced (MyBroadband, 2018).

It is clear that the implementation of mobile and digital learning is not without challenges. From a social perspective, digital-only environments can create a barrier between learners and teachers who no longer have a space to engage face-to-face and provide dynamic feedback. Social environments can benefit learners who learn socially, whereas digital-only environments require learners to have a high level of maturity and self-discipline in their learning. This also reflects upon the learning theories put forward by Millwood (2013), as seen in Figure 2, which underscore the fact that the act of learning is not universal and can require a blended approach with a diverse array of inputs. This might not be attainable in digital-only environments.

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Besides the barriers and challenges related to the social aspects of mobile and digital learning, there are also many technological challenges and limitations in both the hardware and software of these devices. The compatibility issues related to off-the-shelf technologies, the lack of free and stable connectivity, and most importantly, the maintenance and peripheral support that goes along with mobile and digital learning all add to a new set of challenges for both schools and users. As Participant-1 explains, even though mobile and digital technologies may bring cost benefits to some budgetary aspects, such as paper and printing costs, these are quickly outweighed by maintenance and technical support costs are required for a sustainable operation.

It must also be acknowledged that mobile and digital learning is not necessarily welcomed by all. It was found that older teachers are often reluctant to adopt new learning technologies, as these require new skillsets and workflows. In contrast, learners who mostly need little to no training on the use of new technologies are able to misuse the technology by bypassing the security features of some devices to access non-educational content, such as apps and games, which can distract them from learning. This reflects the findings by Ladd and Vigdor (2010), who noted that such distraction can cause a decline in the reading and mathematics scores of learners in certain socio-economic sectors.

The aspect of language has been raised by both Participant-3, who is a software systems analysis and Participant-5, who is a software systems trainer, and is considered to be an important but challenging aspect to attempt to solve. Even though "English is an urban language of public life, widely used in the media, business and government" (Alexander, 2021), it is critical to understand that learners may rely on supporting structures, such as parents at home, who might not have a good comprehension of English, and are therefore unable to assist them with learning at home. On the one hand, as Varyam noted, learning in one's mother tongue can help learners "visualise and develop a better understanding of the subject taught in the classroom" (2020), which most definitely can be a great benefit to learners. However, on the other hand, learning in one’s mother tongue often requires a process of relearning to be able to adapt to an English predominantly English environment later in life. From a technological perspective, it is also challenging to localise content into languages in which new technological buzzwords such as 'artificial intelligence'[34],

[34] Artificial intelligence (AI) refers to a computing method that leverages of software-based machines to mimic the problem-solving and decision-making capabilities of the human mind (IBM Cloud Education, 2020)

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'augmented reality'[35], 'quantum computing'[36] and 'blockchain'[37] amongst others do not exist. It is not only important to attempt to localise the content to the leaners' mother tongue, but also to localise the content regionally and contextually. For example, consider a maths problem with cattle as items to calculate for a rural inland school instead of a maths problem with fishing boats, as these learners might never have seen such a thing owing to their geographic placement.

The participant responses in the individual research engagements have clearly highlighted the need for improved mobile and digital learning in schools. A common thread has also started to emerge through both the teacher and industry professional participant responses, who have all suggested that a unified and coherent system of sorts which can integrate and scale to individual school needs might be a good start in an attempt to improve the implementation strategies of mobile and digital learning solutions in South Africa. It is believed that the centralisation of such a system with maintenance, support and training programs is possible. However, such an endeavour would need adequate funding, support from government with focused leadership and the most qualified and experienced implementation agencies in place that can fully understand the complexities of the social, political, and economic aspects relevant to South African education.

As Participant-3 indicated, a good system does not need to be perfect, but it must be reliable and consistent. It is believed that such an approach might be more achievable than attempting to shoehorn a classroom environment onto a mobile or digital learning device with the government's current 'one-device-per-child' digitisation strategy (Spaull, 2019). It was established, from the individual interviews with the selected research participants, that further research engagements would be valuable in an attempt to develop a framework for designing South African mobile learning experiences.

[35] Augmented Reality (AR) refers to a digitally enhanced version of the physical world, with visual elements, sound and other sensory stimuli, made possible through the use of digital technologies (Hayes, 2020).

[36] Quantum computing refers to the quantum mechanics that the system uses to calculate outputs. In physics, a quantum is the smallest possible discrete unit of any physical property (Azure, 2021).

[37] Blockchain refers to a type of electronic database, which stores data coherently in a structured way, also known as blocks and has references to the preceding and subsequent block, effectively creating a chain of data (Conway, 2021).

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4.1.2 Analysis of Research Probes

In order to develop the structure for a participatory design engagement, the research participants were each asked to submit three research probes (Addendum 9). The request for research probes aimed to "collect ideas for creative solutions" (Boehner & Graber, 2012) and to act as a point of departure where the research could be directed by the participants and not led by the researcher. The fifteen research probes collectively submitted by the research participants (Addendum 12) have been summarised as follows:

All three research probes submitted by Participant-1 were links to online training resources about Microsoft Teams. Two of the links were text-based resources that provided tips for using the platform (Figures 16 and 17). Participant-1 also submitted a link to a YouTube training video specifically aimed at providing tips to teachers on how to use the platform effectively (Figure 18). This possibly gives insight into the fact that most teachers had to take initiative and train themselves on how to use the tools of the 'new' digital learning environment which was suddenly enforced owing the COVID-19 restrictions and lockdowns. It is therefore evident that the current onboarding processes for teachers lack focus on the technical and practical skills required to use the technology effectively. The inability to use the technology effectively can distract from the teaching activities of the teachers, and can also affect the quality thereof.

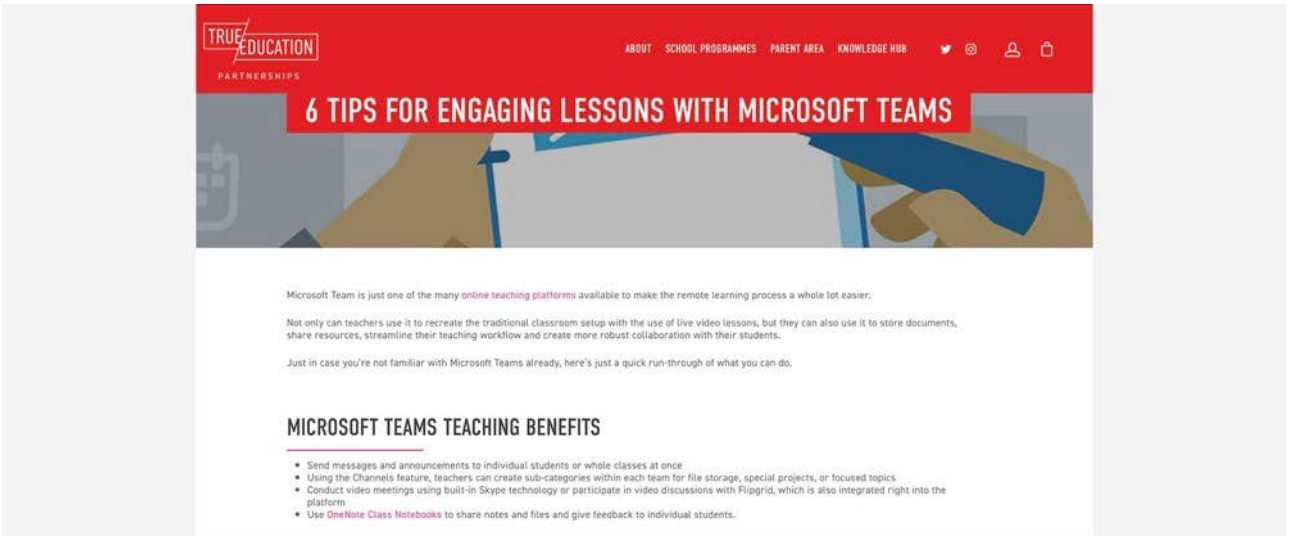

Figure 16: True Education article - 6 Tips for engaging lessons with Microsoft Teams (True Education, 2021).

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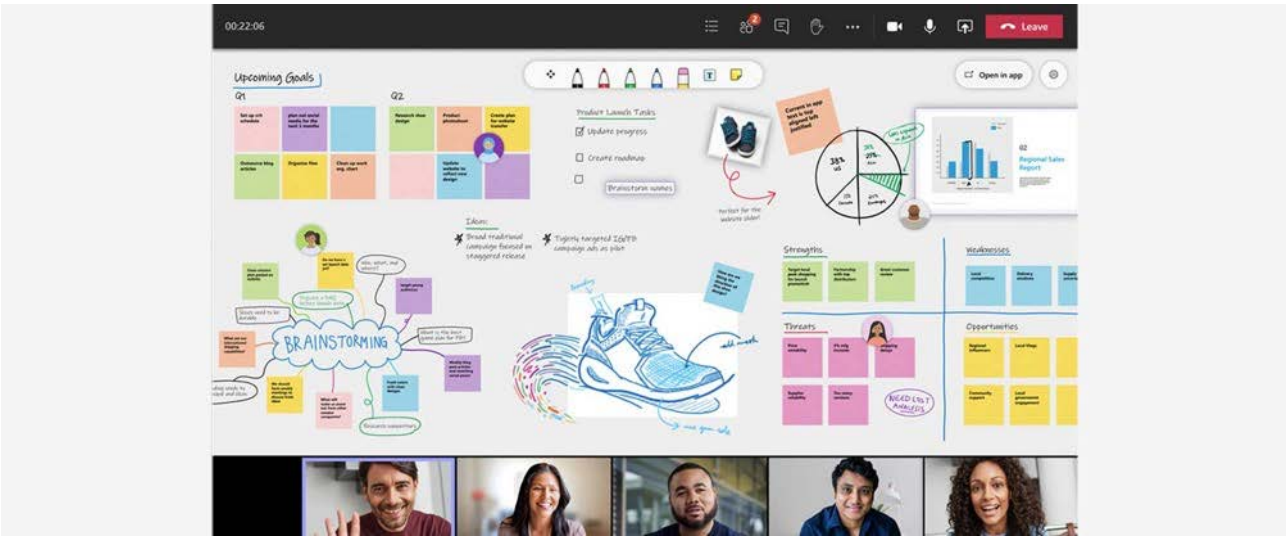

Figure 17: Microsoft Teams Whiteboard features (Microsoft, 2021).

Figure 18: Microsoft Teams training video (Microsoft, 2021).

Participant-2 submitted two links, one to the e-learning software used at their school (Figure 19), and the other to the e-learning service provider appointed to manage their digital and mobile learning implementations (Figure 20). Even though this implementation can be considered to be 'off-the-shelf', it is important to note that both the mobile application and the service provider is South African based. It is possible that solutions that are developed in South Africa might take the local social, political and economic aspects into consideration. However, there are an increasing number of companies who offer 'white-label'[38] products that tend to be completely disconnected to the local context. Participant-2 also submitted an

[38] A white-label product is a generic mass market product that is developed by one company then sold to other companies who rebrand the product as their own (Prijanka, 2021).

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example of an online lesson, which was created on Microsoft PowerPoint and includes comments and voice-over recordings (Figure 21) in the attempt to convey all the necessary information to the learner digitally. The online lesson created by Participant-2 demonstrates how resourceful teachers need to be with the technology available to them. It is evident that teachers need to have flexible platforms, that are feature rich in order to have the ability to teach without the hurdles caused by limitations in the technology they use.

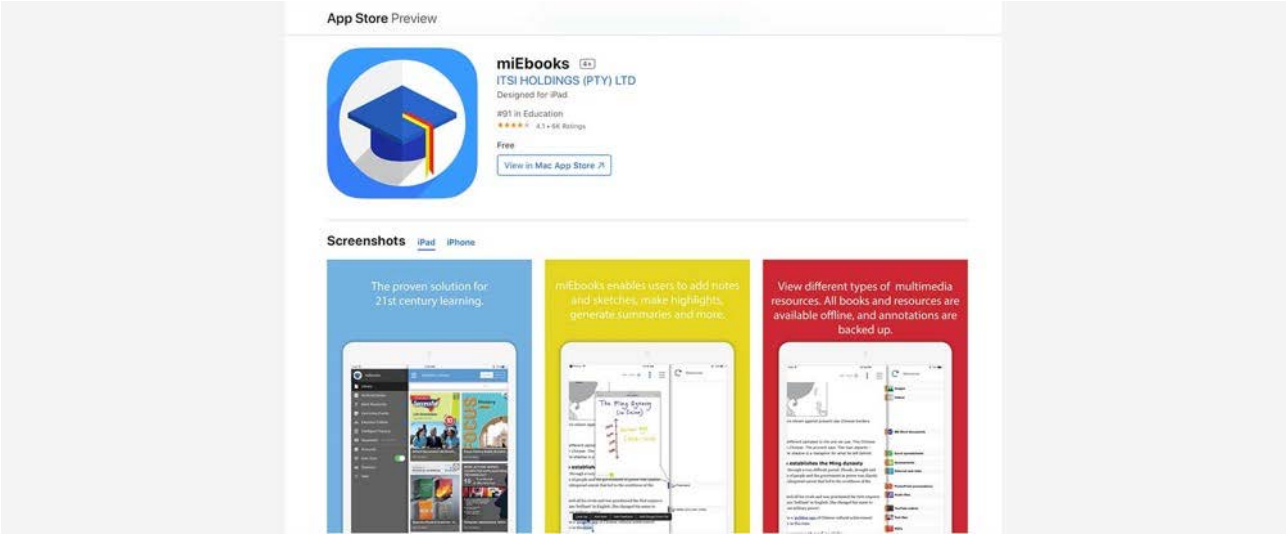

Figure 19: myEbooks mobile application (miEbooks, 2021).

Figure 20: ITSI Education website (ITSI, 2021).

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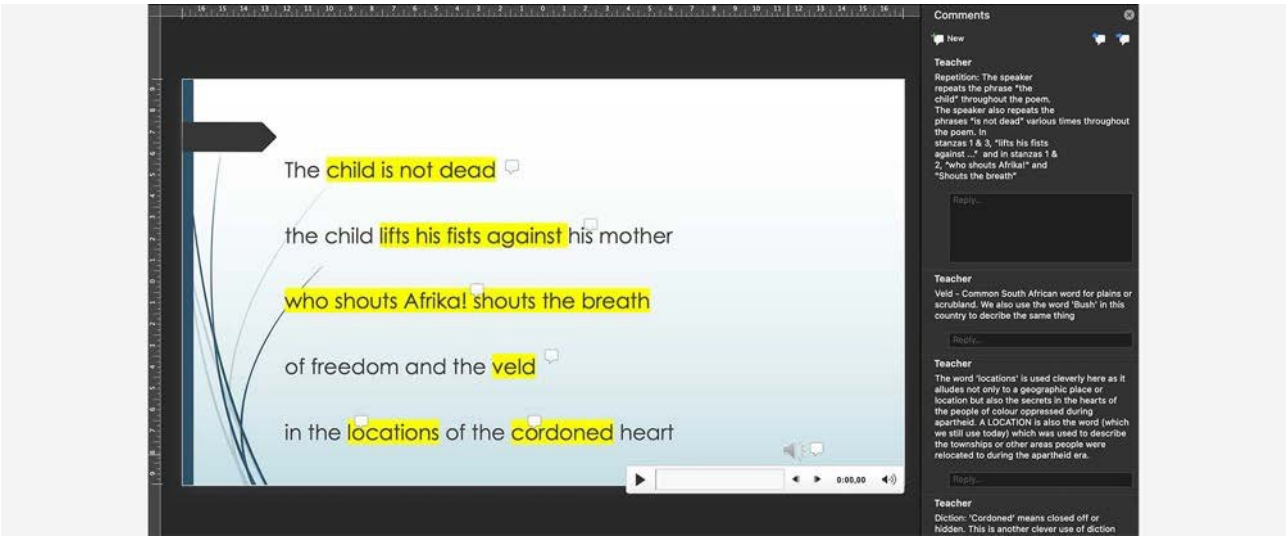

Figure 21: Online PowerPoint lesson (Participant-2, 2021).

Participant-3 submitted links to three articles about teaching and learning in one's mother tongue as research probes. In the first article (Figure 22), Savage explained that learning in one's mother tongue, especially during a child's development phase, fosters other essential skills "such as critical thinking and literacy skills" (2019). These skills and concepts then become innate and do not have to be re-taught when the child transfers to a second language. In the second article (Figure 23), Nulkar explained that the "concepts and literacy skills picked up when learning the mother tongue can be extrapolated [...] and are, in fact, a strong predictor of a child's overall linguistic ability" (2017). In the third article (Figure 24), Gandhi explained that "[l]anguage is the key to inclusion" and that it provides individuals with the ability to connect to their traditions and roots (2016). It is therefore important that the use of language in digital and mobile learning is considered, especially given the fact that South Africa has eleven[39] official languages and diverse cultures.

[39] South Africa's Constitution recognises 11 official languages: Sepedi, Sesotho, Setswana, siSwati, Tshivenda, Xitsonga, Afrikaans, English, isiNdebele, isiXhosa and isiZulu (Alexander, 2021).

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What is mother tongue in education?

Mother tongue in education refers to when a school or educational institution integrates the language a child is most familiar with (their mother tongue) into the classroom lesson along with the school's lesson (such as English). This is normally the language that the child speaks at home with their family.

Figure 22: IE-Today article - The importance of mother tongue in education (IE-Today, 2021).

Figure 23: LinkedIn article - 5 Reasons why it is important to know your mother tongue really well (LinkedIn, 2021).

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The book is tailored towards an audience that does not know Gujarati at all. There is text in Gujarati within the book, but it is all transliterated. There is also a short lesson at the end on basic conversation. I hope that resources like these will help people learn their mother tongue and spread the knowledge on to the next generation.

Figure 24: Kitaabworld article - Five reasons why you must teach your child your mother tongue and how you can do it (Kitaabworld, 2021).

Participant-4 submitted links to two articles, and a link to a mobile learning application. The first article is about 'Starlink' (Figure 25), a company based in the United States of America, which uses a constellation of satellites to beam high-speed broadband internet down to receivers. According to Daniel, Starlink's services are anticipated to launch in South Africa in 2022 and will aim to connect rural areas left out of the fibre rollout. The second article (Figure 26) is about Facebook's bold statement in 2013 regarding their humanitarian undertaking to provide universal basic internet services to all globally. However, this undertaking did not go as planned, according to Hempel, who noted that the failure to make any significant progress five years on was "forcing Facebook to reckon with the limits of their own ambition" (2018). The mobile application submitted by Participant-4 as a research probe, is Free Basic (Figure 27), a mobile application developed by Facebook in 2018 that provides free and unrestricted access to basic websites and services including Facebook, AccuWeather, BBC News, ESPN, UNICEF and Dictionary.com. The application is part of Facebook's Internet.org initiative, according to the Google PlayStore, which is also undertaking the provision of universal basic internet service to all. There has been a major increase in the commitments and initiatives by Big Tech[40] in providing access to internet and resources to underprivileged communities. It is therefore important for developers and implementers of digital and mobile learning to find ways to potentially capitalise on commitments to maximise possible opportunities.

[40] The term 'Big Tech' refers to the major technology companies such as Apple, Google, Amazon, Facebook and Microsoft, which have inordinate influence (PC-Mag, 2021).

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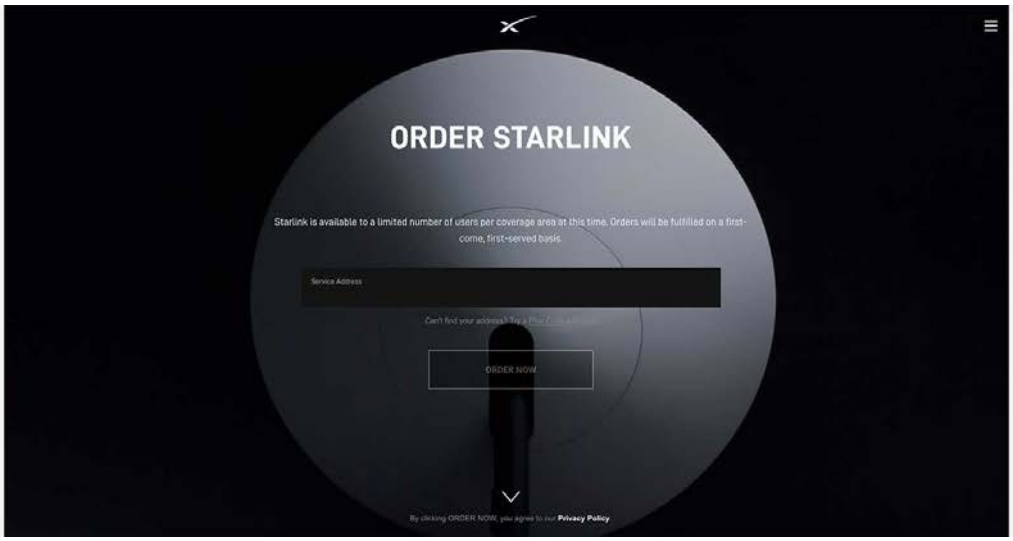

Figure 25: Starlink website (Starlink, 2021).

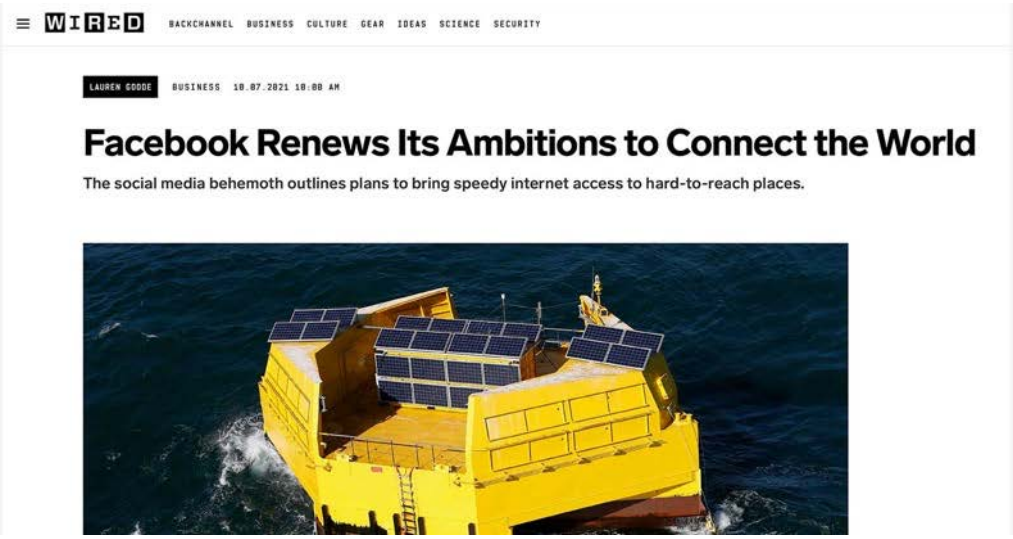

Figure 26: Wired article - Facebook renews its ambition to connect the world (Wired, 2021).

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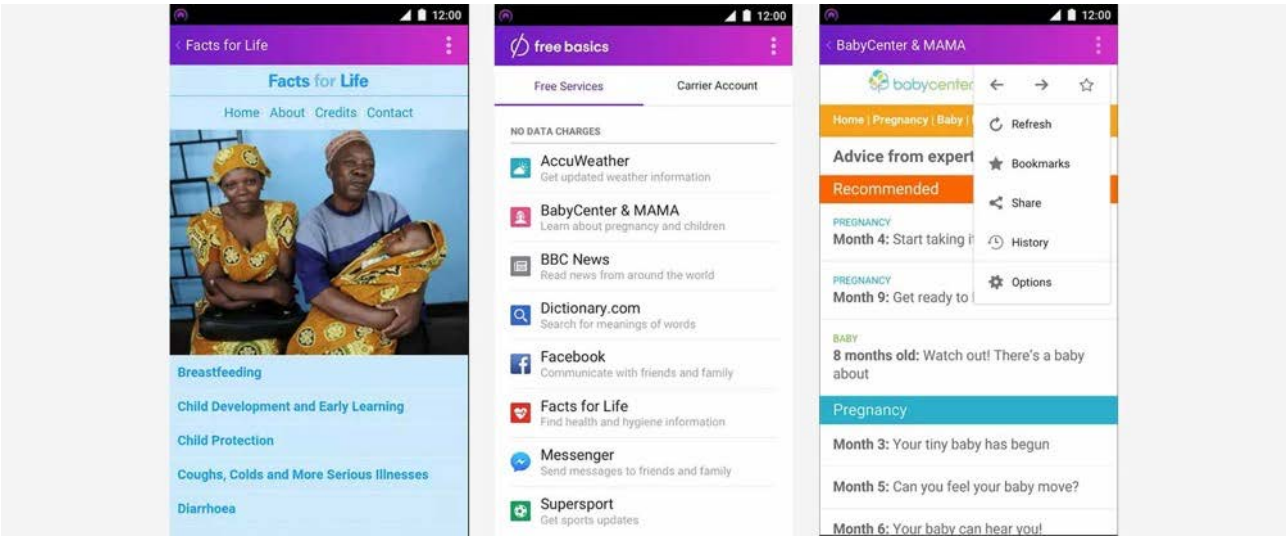

Figure 27: Facebook's 'Free Basic' mobile application (Free Basic, 2021).

Participant-5 submitted links to three articles about Open Educational Resources (OERs). In the first article (Figure 28), Jacobs explained that OREs fundamentally reshape "the way we think about the production, distribution, and the sharing of software as an artifact", which challenges the "notions of property rights and authorship, and [...] inspires new socio-economic relationships and countless innovations" (2014). In the second article (Figure 29), Wiley noted that there has been a significant increase in the development and use of OREs since 2010, and that "in the near future 80 per cent of general education courses would replace their commercial textbooks with OER" (2014). In the third article (Figure 30) Wiley noted that 80 per cent of all general education courses taught in the US will transition to OER in the next five years" (2014). Nearly a decade on, it is interesting to observe that the dominance of the open-source environment was anticipated to have a sharp upwards trajectory before the global COVID-19 pandemic, which now demands it as a necessity.

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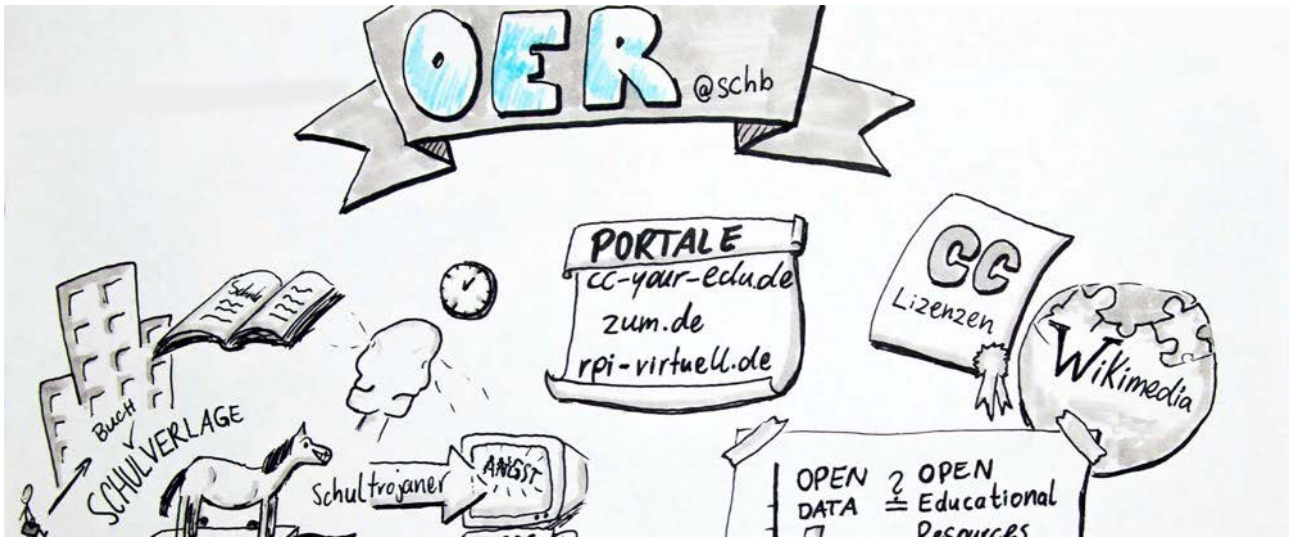

Figure 28: EdSurge article - Open educational resources.

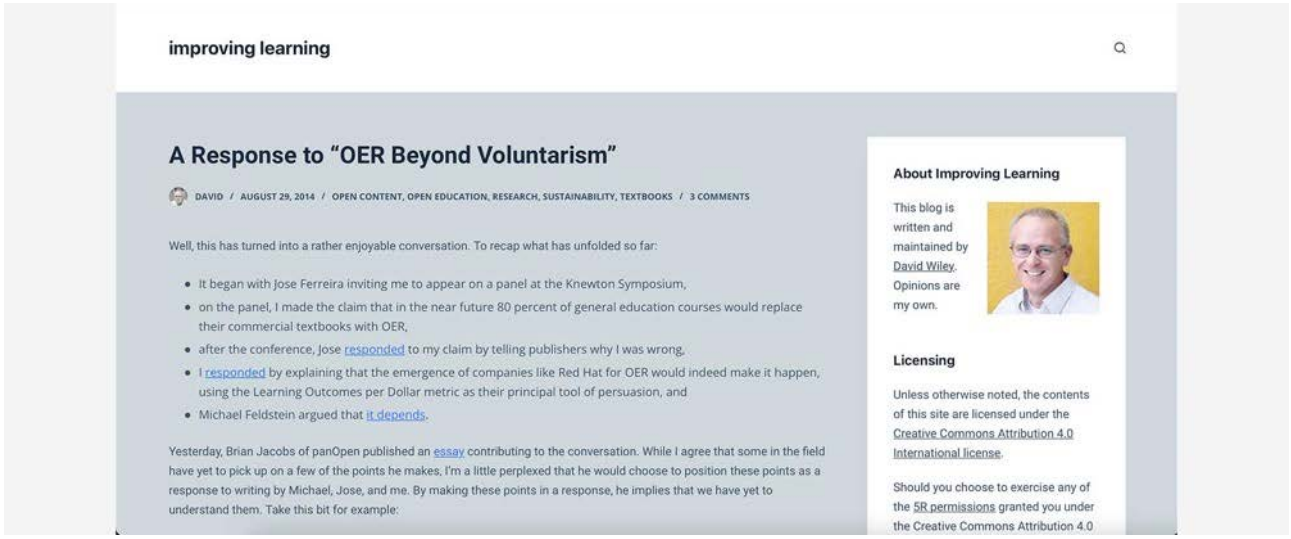

Figure 29: Open Content article - A Response to "OER Beyond Voluntarism".

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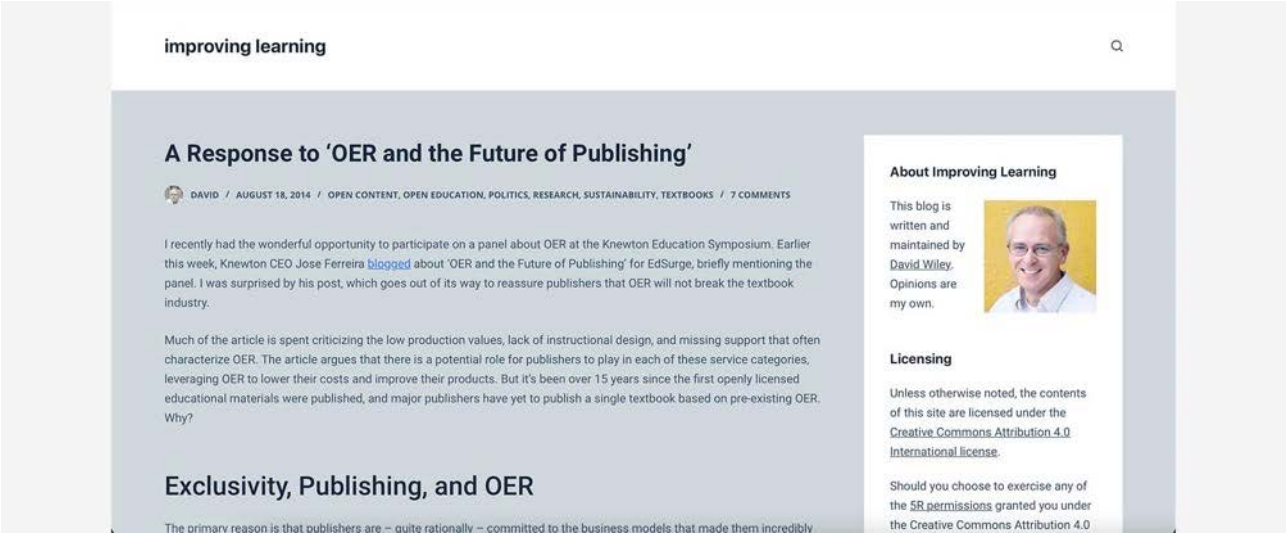

Figure 30: Open Content article - A Response to "OER and the Future of Publishing".

4.1.3 Analysis of Participatory Design Engagement

As outlined in Chapter 3.2 Research Design, the research participants attended a two-hour participatory design engagement aimed at discussing the topic of mobile learning, within a South African context from the individual perspectives of each participant. The engagement consisted of eight activities, as outlined in Table 9.

Activity 1 - Pre-engagement Interviews

The engagement commenced with participants stating their expectations of what such a participatory design engagement could reveal. Both Participant-1 and Participant-2 were interested in new ideas and were open to learning new ways in which they can improve the mobile and digital learning experiences they have created in their own classrooms while Participant-3 explained that many are attempting to find solutions for the successful implementation of mobile and digital learning in South Africa, but there is no framework, or best practices yet on which to build. Lastly, Participant-4 and Participant-5 placed emphasis on the practicality of possible solutions, as they mentioned that South Africa has the skills and policies in place but lacks the political will and concerted effort to implement a coherent strategy that is suitable for the South African environment. It is therefore evident that a framework for designing South African mobile learning experiences is needed and can potentially provide a mechanism which can, in turn, help shape future attempts to be more successful.

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Activity 2 - Personal Experiences with Mobile Learning

In order to contextualise mobile learning within this participatory design engagement, the participants were asked to provide an outline of how they engage with mobile or digital learning (or elements thereof) in their individual environments or professions. Participant-1, who is a teacher, explained that their school has fully implemented mobile and digital learning in terms of providing all content online and integrating the use of digital learning devices in all classrooms. Participant-1 noted that even though the process of digitising the learning environment was already being phased in, the rapid teacher onboarding due to the South African COVID-19 pandemic lockdown was scary and frustrating. This was owing to the immediacy of the situation, the lack of training to use digital-only environments, and the lack of infrastructure and resources to convert all the required educational content and workflows into digital formats. Participant-1 confessed that teaching during the lockdown periods under Alert Levels 5 and 4 was extremely stressful, frustrating, and exhausting owing to the sudden increase in required work hours and lack of boundaries between work- and personal life.

Participant-1 further explained that the re-opening of schools under Alert Level 3, brought another set of challenges and changes in how teachers conducted their teaching. In the attempt to decrease the spread of the coronavirus, teachers now moved between classrooms while learners stayed in a single classroom for all lessons. All learning materials have been uploaded onto the cloud and teachers have been equipped with Apple iPads, which are connected and controlled by 'Jamf Pro'[41] to create a centralised network amongst teachers and learners. Learners can only use dedicated learning devices during lessons and no cell phones or other personal computing devices are allowed. However, the challenge is that if there is no connectivity during class times owing to load shedding or other power outages, then access to digital educational materials and resources is limited or completely unavailable. This often requires for the lesson to revert back to paper textbook methods to avoid a loss in work.

Unfortunately, as noted by Participant-1, there does not seem to be an improvement in the performance of learners who did not perform well before the implementation of digital and mobile learning in the school. It is said that younger learners below grade 8 tend to 'netflix'

[41] Jampf Pro is an application used by system administrators to configure and automate IT administration tasks (Jampf, 2021).

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the course material, which means that they watch the digital material (videos and pre-recorded lessons) without any comprehension. Participant-1 further notes that it has become evident that lazy learners remain lazy, irrespective of a more convenient and accessible learning environment.

Participant-2, who is also a teacher, is based at a school with a lower economic base as compared to that of Participant-1. Digital and mobile learning in their school was only implemented to grades 10 to 12 during the lockdown periods under Alert Levels 5 and 4 by means of WhatsApp groups and e-mail forums, however, digital and mobile learning has now been rolled out to grades 8's and 9's since the re-opening of schools under Alert Level 3. Owing to the low economic base of the school, learners are not expected to be online after school hours, as some learners do not have reliable electricity and/or data access. Learners who have their own or government-sponsored tablets are therefore allowed to upload and download content while connected to the school's Wi-Fi during school times.

The biggest challenge, according to Participant-2, is the lack of school infrastructure to support the full implementation of digital and mobile learning in their school. Even though their school has a support agreement with the local service provider who has provided both the hardware and software for their school, teachers are often required to perform IT support-related duties, such as installing software or setting up connections to networks. According to Participant-2 this not only distracts teachers from teaching, but also results in additional pressure on teachers who might not be as tech-savvy.

Participant-3 believed that the implementation of digital and mobile learning technologies in schools needs to be developed from a sound feasibility study and implementation audit to establish the school's preparedness for such a process. Such an approach, which can advise on customised implementation strategies, will also avoid the current blanket approach by government, which has mostly failed to date. Throughout the discussion, Participant-3 also placed emphasis on the support required to sustain the implementation of digital and mobile initiatives in schools. This can possibly include an internal IT support department or dedicated call centre that can manage all hardware and software issues for both staff and learners. The IT department can also provide courses for teachers to upskill them with the latest digital teaching methods and techniques.

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Participant-4 shared similar suggestions regarding the upskilling of teachers to help them meet the new digital demands which they are facing. To do this effectively, Participant-4 suggested that the schools should create a dedicated training space or excellence centre for the purposes of onboarding of users, the facilitation of training and skills transfer programs, as well as a space to conduct research and pilot new digital and mobile learning projects. It was also suggested that schools should find ways to access and utilise the available local municipal infrastructure and resources, such as free Wi-Fi hotspots and device charging facilities.

Participant-5 seconded Participant-1's observation regarding how younger learners 'netflix' course material without comprehension by noting that learners are more likely to fall into a habit of social loafing[42] when placed in a digital environment that offers limited or no direct in-person feedback. As a software systems trainer, Participant-5 also discussed the possible options available for the onboarding and upskilling of teachers to meet the digital teaching demands which they are facing by proposing that a 'tech-to-teacher-translator' course or strategy be implemented at schools. This can ensure that all teachers are equipped with the necessary skills and knowledge to navigate the digital teaching environment and avoid the situation where younger teachers are often required to provide ad-hoc technical support to older teachers who view them as more tech savvy owing to their age.

Activity 3 - Material and Social Elements of Mobile Learning

Based on the participants' personal experiences in mobile learning, as discussed in Activity 2, the researcher requested that the participants collectively decide on material and social elements of digital and mobile learning which they considered to be of importance. These elements, which were viewed as 'actants' within the context of sociomaterialism, were written in coloured markers on a blank A2-sized paper in an attempt to map the relationships among them. The first two actants that were agreed upon were 'technology' and 'social', which were placed on the page on the far right and far left respectively. The participants agreed that these two actants form the base of digital and mobile learning, which reflects the theoretical perspectives of sociomaterialism. The researcher then asked the participants "Within proximity to the 'technology' and 'social' actants placed on the diagram, where does the 'teacher' and 'learner' fit in?" Participants agreed that the both the teacher and learner

[42] Social loafing, in social psychology, refers to the phenomenon of a person exerting less effort to achieve a goal when they work in a group than when working alone (Cherry, 2021).

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should be placed between 'technology' and 'social' actants, with the 'learner' central to the assemblage formed by the 'technology', 'social' and 'teacher' actants, as seen in Figure 31.

Figure 31: Actants of mobile learning.

These four actants (technology, social, teacher, and learner), which were initially viewed as separated entities by the participants, formed the base of the diagram to which all agencies responded based on their proximity to the actants. The agencies, which related to the social and material elements discussed in Activity 2, were listed at random based on suggestions from all participants. The following twenty-one agencies were added to the diagram, as listed in Table 11, which includes a summarised motivation drawn from the discussions among participants.

Table 11: Agencies of mobile learning.

Agencies:		**Summarised Motivation:**
1.	Privacy	The participants suggested 'privacy' for the teacher, who is often contacted by learners and parents after school hours, as well as the learner, who needs to feel comfortable and safe using the mobile learning platform.
2.	Home Environment	The 'home environment' was put forward by participants in reference to the physical space where teachers and learners use the digital and mobile learning technologies when they are

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		not at school. It was noted that the home environment can also bring its own set of challenges. Participant-1 explained that they are often distracted from teaching, owing to the needs of their three-year-old child, who was also home during the COVID-19 lockdown.
3.	Social Loafing	The participants felt that the agency of 'social loafing' was difficult to place, as a learner can 'loaf' in both the social and technology environments. However, it was ultimately decided that 'social loafing' primarily occurs between the learner and teacher, as learners tend to provide non-meaningful participation in a digital environment where there is a lack of in-person feedback.
4.	Onboarding	The 'onboarding' agency was primarily directed at teachers, as Participant-1 and Participant-2 believed that teachers first need to be upskilled to be able to teach in the digital environment. The onboarding of learners can then follow, as learners have an extremely quick uptake in learning new technologies.
5.	Engagement	Two versions of 'engagement' were put forward during the discussion: Firstly, that between the learner and the teacher as learners need to learn a new set of rules on how to engage with their teacher in the digital environment; and secondly, learners need to learn how to engage with the technology.
6.	Management	The 'management' agency was added to represent all managerial structures under which the teacher needs to operate, such as the school's management and the Department of Basic Education. Even though this hierarchal view contradicts the flat ontological perspective of the research, the participants still consider these as structures 'above' them.
7.	Infrastructure	Two versions of 'infrastructure' were put forward during the discussion: Firstly, as a pairing with 'management' as it was

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		believed that management is responsible for the infrastructure in which the teachers and learners are located or are using (i.e. physical classrooms, Wi-Fi hotspots, etc.); and secondly, 'infrastructure' as an agency specifically related to the 'technology' actant, owing to the fact that the hardware and software of digital and mobile learning devices are defined as infrastructure.
8.	Collaboration	The 'collaboration' agency was placed central to the four actants (technology, social, teacher, and learner) owing to the fact that collaboration involves all actants and can relate to further agencies.
9.	Autonomy	Two versions of 'autonomy' were put forward during the discussion. Firstly, the autonomy of the learners who need to have the space and ability to work on their own (physical space, supportive environment, technical abilities, available hardware and software) was mentioned; and secondly, the autonomy of the teachers who need the freedom and resources to create their own processes which suit their teaching styles and the content of the subject matter was significant.
10.	Orientation	The 'orientation' agency, which was viewed similarly to the 'onboarding' agency, was placed in relation to the 'infrastructure' and 'management' agencies. This, in turn, relates to both the teachers and learners, as teachers need to transfer the knowledge and skills to the learners.
11.	Monitoring	The participants believed that the 'monitoring' agency was believed to be primarily related to the 'teacher' actant, as it was noted that in the event of there being no technology, monitoring of a learner’s progress will still need to continue.
12.	Technology	Even though 'technology' was placed as an actant in reference to the overarching concept of technology in digital and mobile

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		learning it was also added as an agency in reference to the physical devices which teachers and learners use. Therefore, 'technology' as an agency was placed central to all four actants (technology, social, teacher, and learner) owing to the fact that is serves as the platform on which digital and mobile learning can occur.
13.	Resources	Participants paired the 'resources' agency with the 'infrastructure' agency, as they were defined similarly. It was noted that the infrastructure must contain resources for digital or mobile learning to occur.
14.	Comprehension	The participants agreed that the 'comprehension' agency related mostly to the 'learner' actant, as learners need to take in and understand the knowledge that is conveyed to them.
15.	Accountability	Two versions of 'accountability' were put forward during the discussion. The participants explained that accountability flows upwards, therefore the learners are accountable to the teachers and the teachers in turn are accountable to their management. It was acknowledged that this, again, puts forward an hierarchal view which contradicts the flat ontological perspective of the research, but is the reality of the situation.
16.	Data	The participants believed that the 'data' agency, which was defined as access to the internet, relates to both the 'technology' actant and the 'infrastructure' agency.
17.	Accessibility	The participants believed that the 'accessibility' agency relates to the 'infrastructure' agency, as it could flow to all connected agencies from there.
18.	Learning	The participants related the 'learning' agency to all four primary actants (technology, social, teacher, and learner) as the process

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		of learning is affected by and related to nearly all other agencies.
19.	Integration	The participants defined the 'integration' agency as an underlying feature that facilitates the connection between actants and agencies.
20.	Support	The 'support' agency was paired with the 'management' agency as the participants believed that it is the responsibility of management to provide support and resources. This allocation was due to the teachers feeling that they do not have the capacity to provide support outside of the management structure.
21.	Centralisation	The 'centralisation' agency is also paired with the 'management' agency owing to its role and responsibility within the environment of digital and mobile learning.

A progress photograph of the diagram drawn up during Activity 3, which lists the four actants and the twenty-one agencies as suggested by the research participants, can be seen in Figure 32. Upon reviewing the diagram, participants noticed that there is a lack of social agencies. Participant-2 noted that the agencies mostly relate to the technology, teacher, and learner actants, as well as the management agency, which started to emerge as an actant in itself. Participant-1 responded to this observation by objectively stating that they, the participants, are possibly viewing the process from a teacher's or professional's perspective, and not from the perspective of a learner, hence the lack of social agencies. Participant-3 commented that it is possible that the social agencies are less relevant to this process than previously considered, and that the agencies do not need to be spread equally amongst the actants.

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Figure 32: The actants and agencies of mobile learning.

It was interesting to observe, from a researcher's point of view, how participants negotiated between the material and social elements of the process and how instinctively they attempted to balance these elements. Even though the research process and the development of the diagram followed a flat ontological perspective, with emphasis on the principles of sociomaterialism (which states that the social and material aspects are of equal importance), the participants evidently felt uncomfortable with the resulting diagram that listed fewer social agencies than initially anticipated. Additionally, it was noteworthy to see how quickly the agencies of mobile learning started to overlap and 'entangle', as illustrated previously by Cecez-Kecmanovic in Figure 1.

Activity 4 - Break

Participants welcomed the mid-engagement break. Interestingly, even though the topics of discussion immediately changed to personal conversations after the break was announced, they quickly returned to the topic of digital and mobile learning when the host, Participant-3, demonstrated how intuitively their three-year-old child uses their tablet to watch educational programs about dinosaurs on YouTube without the ability to read. Participant-3 explained that this might be due to the intuitive interface design of both the tablet and the application, which naturally led to the next activity.

Activity 5 - South African Context

This activity was included to allow the participants to expand on the material and social aspects listed on the diagram, with specifically reflecting on the South African context.

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However, as seen through the participant responses during the individual interviews and Activity 2 of the participatory design engagement, it became evident that both the teacher and professional participants' views are embedded in the South African context, as it is the environment in which they operate. They often face the same challenges as learners, especially during the South African COVID-19 lockdown, when access to resources and the educational environment (owing to the closure of schools) and access to electricity (owing to continued load shedding) became limited for them as well. It is therefore believed that the 'lens' through which the research participants are viewing their own challenges, the challenges of their learners, the challenges found in the professional industry, as well as the research study itself, is a lens that is sensitive to the social, political and economic environment of South Africa.

Activity 6 - Link and Group Elements

The process of identifying and negotiating the relationships among the different elements of the diagram was a natural progression in the research process. The participants were their most active during this process as it became more apparent how much these elements relate and interrelate[43], as well as how perceived hierarchal structures are no longer relevant when the process is 'flattened'. The process of linking elements also revealed a deeper contextual understanding of the actants and agencies. For example, as seen in Figure 33, 'data' which was initially related to the 'technology' actants and the 'infrastructure' agency, was now also linked with the 'social' actants, owing to the fact that some teachers do not have Wi-Fi at home, which can limit their ability to teach on and engage with the relevant digital and mobile learning platforms.

[43] As verbs the difference between relate and interrelate is that relate is to tell in a descriptive way while interrelate is to form relationships between multiple things (Wikidiff, 2021).

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Figure 33: Discussion about links and groupings on the participatory design diagram.

In their observations, Participant-2 noted that there were only a few new links drawn during this process between the learner and other elements. This could again be the result of not including a learner in the participatory design process, or an indication that the learner has more of a passive role during the implementation of digital and mobile learning in schools. Along with the lack of links to the 'learner' actant, the lack of links to the 'social' actant was also noticeable. In this light, Participant-4 stated that this process (the implementation of digital and mobile learning in schools) is perhaps trying to recreate, in a microcosm[44], what schools have evolved to do over a few hundred years. Therefore, the lack in social agencies might be a future occurrence once society has fully adopted and normalised this process, which will then allow for social elements to emerge.

Agencies such as 'onboarding', 'engagement', 'orientation' and 'comprehension' also became more intertwined during the discussion, as these do not only relate to the learner, as previously thought, but also relate to the teacher and to a certain extent, to the learner's home environment. Participant-1 and Participant-2 explained that the lack of comprehension seen in learners, for instance, could possibly be attributed to the lack of training on how to learn on digital and mobile learning platforms. Participant-3 agreed and added that the implementation thereof should also include a course on online etiquette (or netiquette[45]), so that learners can maintain a level of respect for both the teacher and the online environment.

[44] A microcosm is defined as a community, place, or situation regarded as encapsulating in miniature the characteristics of something much larger (Oxford Dictionary, 2021).

[45] Netiquette is defined as the rules of correct or polite behaviour among people using the internet (Oxford Dictionary, 2021)

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Interestingly, this then relates to the 'privacy' agency and 'social' actant, which should be a part of an online etiquette course in an attempt to mitigate the fact that both learners and parents often contact teachers outside of their work hours.

Participant-2 further explained that learners are also struggling to cope with the return to the classroom environment, as the combination of digital and in-person teaching often requires a greater level of engagement. This is especially owing to the fact that there is less of a separation between school-life and home-life. Participant-1 also noted that there has been an increase in the number of learners who have been diagnosed with anxiety disorders since the COVID-19 lockdown. However, Participant-3 noted that learners who had a healthier integration between school life and home life, and whose parents took an active support role generally perform better within a digital environment. Participant-2 agreed and noted that this is possibly owing to the fact that those learners already had taken ownership and responsibility for their learning, due to the positive support environment. Taking this into consideration, the participants suggested that the 'social' agency can also include environmental agencies, such as a learner's home life. However, with regards to the linked 'technology' agency, Participant-3 questioned the feasibility of implementing a system that could potentially improve social norms and behaviours.

By taking a step back and observing the links and grouping of elements of the completed diagram, as seen in Figure 34 (larger format available as Addendum 13), the participants noted that the overarching process for the implementation of digital and mobile learning in schools leans towards the creation of an environment that facilitates teaching and learning through infrastructural and support elements. It is therefore evident that the key factor for the successful implementation of digital and mobile learning in schools is not the actual device or software itself, but the larger eco-system that it is part of. This finding motivates the aim of developing a framework for designing mobile learning experiences, which is sensitive to the various social, political, and economic factors in South Africa.

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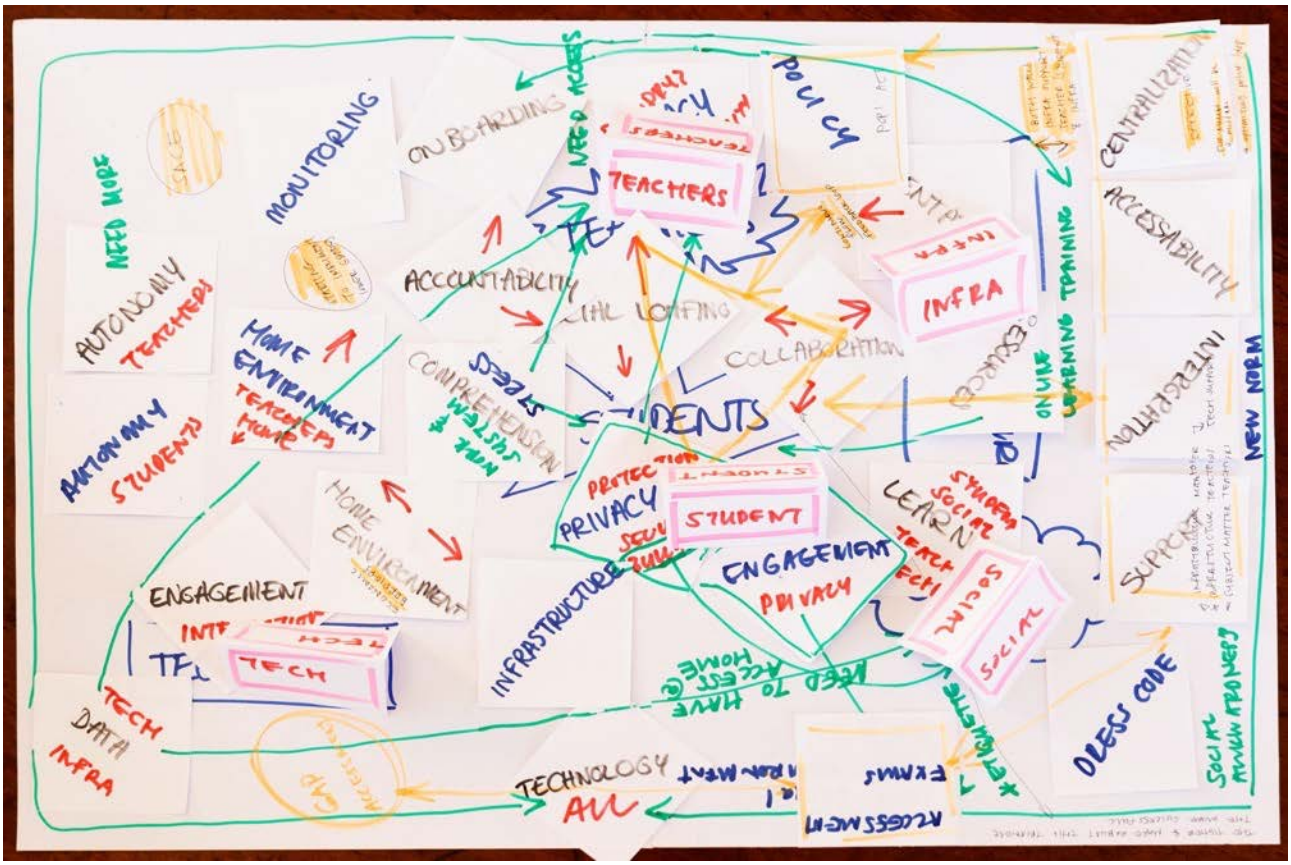

Figure 34: The completed participatory design diagram.

Activity 7 - Identifying the Challenges, Opportunities and Possible Solutions

Upon review the participants agreed that most opportunities for the improvement of the implementation of digital and mobile learning in schools relates to the concentration formed by the 'teacher', 'learner' and 'technology' actants. For example, strategies to enhance the learning and teaching experience, such as teaching learners how to learn online and teaching teachers how to teach online are considered more important than the hardware or software itself. It is therefore proposed that a conducive environment be created which can facilitate the processes between the teacher, learner, and the technology. This, according to Participant-1 would improve the overall success of the implementation of digital and mobile learning in schools immensely.

In turn, as Participant-3 explained, the outcomes and solutions related to the 'teacher', 'learner' and 'technology' actants, need to then inform policy and strategies, creating a bottom-up developmental flow, instead of the current top-down flow, which requires that teachers to merely adopt what is being implemented by management or the Department of Basic Education. Participant-5 gave further insight into the proposed flow of influence by

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noting that with an agile development[46] process, which has a much faster turn-around time on development, the flow between learners, teachers and management can become cyclical. This will create a feedback loop with a possible cycle of refinement.

Activity 8 - Post-engagement Interviews

To conclude the participatory design engagement, the research participants were asked to share any insights gained from the experience which have added to their understanding of digital and mobile learning in South African schools. Participant-1 found it interesting to observe how passive learners are in this process. Even though the research process did not include learners, the implementation of digital and mobile learning in schools seems to follow a top-down process where teachers must adapt to what is being implemented by their school's management or the Department of Basic Education. So, too, must learners adapt to what is being implemented by their school or teachers. Participant-1 believed that in order to improve the implementation of digital and mobile learning in schools, a system needs to be developed that is robust yet flexible enough to allow for customisations by teachers and learners so that the learning experience can be optimised and suitable for the specific situation.

Participant-2 explained that it would be interesting to conduct the same engagement twice more for comparison; a second time with just learners only and a third time with learners and teachers. One could then possibly compare these engagements and test whether a bottom-up development process, which allows the development to be led by its users (the teachers and learners) is at all feasible. Participant-2 emphasised the lack of the necessary social agencies in the process and believed that it could be a contributing factor to the underperformance by some learners, who merely 'netflix' the course material. The underperformance by some learners, potentially owing to the lack of social agencies in the digital environment, also resonates with the advantages and disadvantages of the Social Learning Theories discussed. Participant-2 further explained that there seems to be a lack of structure within the implementation of digital and mobile learning in schools, possibly due to the speed with which this had to happen as a result of the COVID-19 lockdown in South

[46] Agile development refers to a software development process that delivers software functionalities in phases or modules, called sprints, which is then reviewed and refined through a cyclical process. This process offer the opportunity for client inputs and testing at an earlier stage, as compared to software that is developed to completion before being released (Infoworld, 2021).

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Africa. Therefore, it is believed that it would be in the best interests of all stakeholders to develop a system and processes that are governed by policies which are sensitive to the South African environment and appropriately resourced in terms of technical, infrastructural, and training support.

Participant-3 offered a slightly different approach to Participant-1 and Participant-2 by stating that the current shortfalls will resolve themselves eventually through collective societal inputs. Participant-3 explained that it might be beneficial if the process is sped up by flexible temporary solutions being put in place and then optimised and refined over time, instead of waiting for the 'perfect solution'. This opinion reflects that of Yeung, Lim and Rahman's 'Principles for Designing with People' (2018), as seen in Table 5. More specifically, the principles related to 'test and refine' and 'talk less, do more'. It will therefore be beneficial if a implementation process could be developed that is phase-based, where broad elements of digital and mobile learning are implemented and then refined over time to suit the specific needs of the environment and users.

In contrast, Participant-4 explained that the research process has highlighted how vulnerable the implementation of digital and mobile learning is to privatisation. The challenges and opportunities discussed could potentially be solved or achieved by industry, such as the development of flexible and customisable solutions, the inclusion of more secure social agencies for learners, and the mitigation of hardware, software and connectivity issues etc. This could shift, and possibly already has, shifted the perceived moral obligation to provide egalitarian education to an industry focused on privatising and monetising the solutions for their own financial gains. Participant-4 noted that the South African government, unlike the governments of first-world countries, does not seem to have the time or expertise in place to develop effective solutions and can therefore fall victim to exploitation by the private sector.

Participant-5 echoed this opinion and stated there are possible are solutions to most of the challenges facing the implementation of digital and mobile learning in South Africa. Challenges such as access to the internet, access to hardware, access to software, as well as access to training and management programmes can be provided to all schools based on the annual budget allocated the Department of Basic Education, which is over R27-billion

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for the 2021/2022 financial year (Motshekga, 2021). The challenges therefore seems to be a result of failures and incompetency's of government.

4.2 Observations of Participatory Design Research

Upon reflection on the participatory design research process, it became evident that the theoretical perspectives implemented (a flat ontological perspective that is framed by a socio-materialistic perspective) supported the research process and afforded the researcher the ability to navigate and understand the engagements and outcomes of the research.

It was observed that Participant-1 and Participant-2, who are both teachers, naturally highlighted most of the challenges facing the implementation of digital and mobile learning in schools. Their insights into what is already being implemented, as well as the shortcomings thereof, are considered valuable in the attempt to understand the current situation of digital and mobile learning in schools. It was interesting to note that Participant-1 and Participant-2 did not bring up specific hardware or software issues during the discussion, but spoke more regarding the structure, process and stakeholder responsibilities of digital and mobile learning. This gives insight into the notion that a successful implementation of digital and mobile learning does not necessarily depend on the device one has, but rather on the environment in which that device needs to operate.

Participant-3 (software analyst), Participant-4 (software developer) and Participant-5, (software trainer), who are all based in the private sector, were focused on providing solutions to the challenges mentioned by the teachers. They also did not necessarily bring up specific hardware or software issues during the discussion, but spoke more towards optimising strategies, centralisation and supporting structures to improve the implementation of digital and mobile learning. This gives insight into the notion that a successful implementation of digital and mobile learning is also dependent on how it integrates among the various stakeholders including, but not limited to, parents, learners, teachers, school management, the Department of Basic Education, as well as educational resources themselves. It became evident from the discussions during the participatory design engagement that the management, infrastructure, technology, teacher, and learner actants have the most influence on other actants and agencies in the implementation of digital and mobile leaning. It should be emphasised that there is no hierarchy amongst these actants and that they offer a level of entanglement amongst themselves. Figure 35, which

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shows an abstracted view of how the participants arranged these actants, is a sectional representation for the larger assemblage shown in Figure 34. These five actants (management, infrastructure, technology, teacher, and learner actants), which were identified by the research participants, were selected as test samples in the development of a first draft prototype framework for the design of mobile learning experiences.

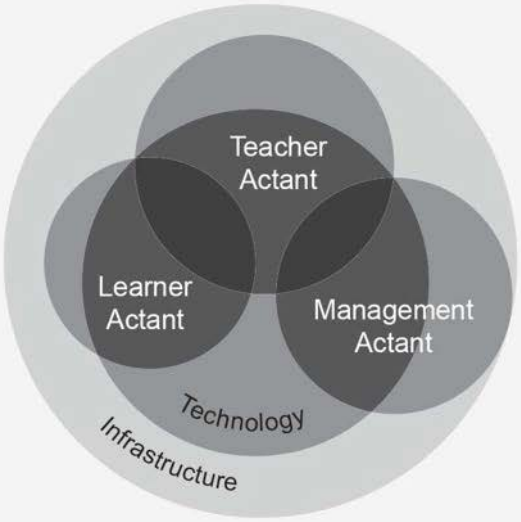

Figure 35: Selected actants of digital and mobile learning (Erasmus, 2021).

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Chapter 5: Design Framework

The participatory design research engagements revealed that the proposed framework for designing mobile learning experiences should be based on a school's preparedness for the implementation thereof. This framework should then offer an appropriate implementation plan to the school, based on its preparedness. For example, if the school has a high economic base with an advanced level of resources, the proposed implementation plan should utilise the existing resources to provide the most optimal strategy for that school. In contrast, if the school has a low economic base with a low level of resources, the proposed implementation plan might include additional infrastructural elements (such as reliable internet access), or additional social elements (such as training programs for teachers) in an attempt to first establish a more suitable and resourceful environment to support the implementation strategy of that school. It is believed that such an approach might offer more effective solutions, as compared to the failures of the 'one learner, one mobile device, strategy currently supported by the South African government (Netshitenzhe, 2018).

5.1 Development of the Design Framework

The participatory design research engagement culminated in an assemblage (Deleuze & Guatttari, 1988), or more metaphorically, an "entwined ball of yarn" (Haraway, 1994), as seen in Figure 34, which needs to be unraveled to some extent to gain an understanding of its relationships and complexities. However, the question persists: "Where does one start, methodologically and analytically, to trace the entanglement"? (Constantinides & Barrett, 2012). In this attempt, the development of the proposed design framework was led by the five actants identified by the research participants. These actants include management, infrastructure, technology, teacher, and learner. It is important to note that the actants are not considered primary or final but are points of departure for the development of a first draft prototype, which can be redefined and refined through further iterations. The actants are therefore proposed in the design framework as Phase 1 (Figure 36).

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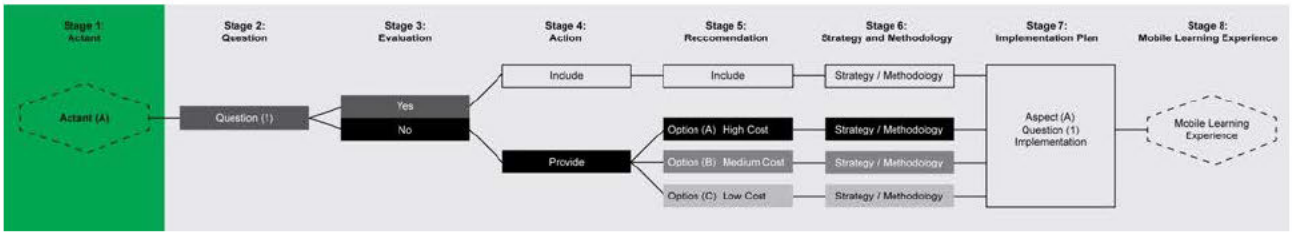

Figure 36: Framework overview - phase 1 (Erasmus, 2021).

It is proposed that Phase 2 (Figure 37) consists of a series of five questions for each actant, which will attempt to gauge the actant' viability or capacity for the implementation of digital and mobile learning. The proposed questions, along with an overarching recommendation for each, are listed in Table 13.

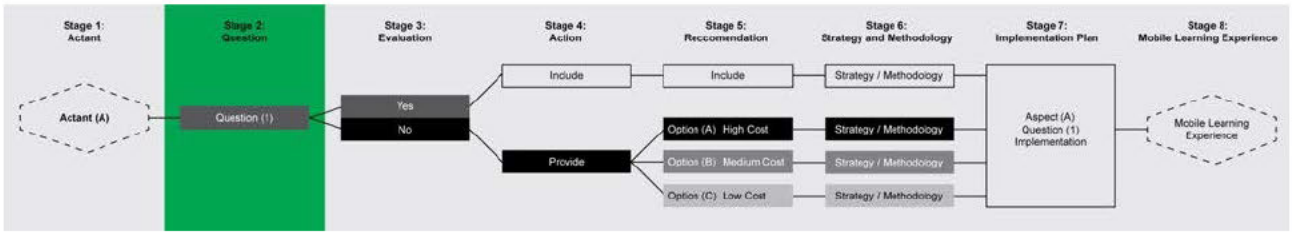

Figure 37: Framework overview - phase 2 (Erasmus, 2021).

Table 12: Phase 2 questions and recommendations for five actants.

Act.	Questions:		Recommendations:
Management Actant	1.	Does the school have a strategic objective in place for the implementation of digital and mobile learning?	It is recommended that the school management, in consultation with the Department of Education, should develop a strategic objective that aligns with the government's national priorities for the implementation of digital and mobile learning in schools.
	2.	Does the school have funding for the implementation of digital and mobile learning?	It is recommended that the implementation of digital and mobile learning should be costed accurately and budgeted for accordingly. If there are no internal funds

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			available, then a funding proposal needs to be developed for the sourcing thereof.
	3.	Does the school have a policy in place for the implementation of digital and mobile learning?	It is recommended that a digital and mobile learning policy should be developed for the school which takes into consideration the management, infrastructure, technology, teacher, and learner aspects of digital and mobile learning.
	4.	Will the management and staff fully adopt the implementation of digital and mobile learning?	It is recommended that the strategic objective, along with the policy for digital and mobile learning, should be fully adopted by the school management and staff. If necessary, an onboarding strategy and programme can be implemented to achieve the full and successful adoption thereof.
	5.	Does the school have the staff capacity for the implementation of digital and mobile learning?	It is recommended that the school should have the capacity to train and place staff to assist with the implementation of digital and mobile learning in a way that ensures the teachers mental health and work-life balance.
Infrastructure Actant	1.	Does the school have a secure and safe environment available for the implementation of digital and mobile learning?	It is recommended that the school should have the necessary security infrastructure and protocols in place to ensure the security and safety of staff and learners for the digital and mobile learning environment.
	2.	Does the school have access to a reliable electricity connection?	It is recommended that the school should have a reliable source of electricity, which can operate independently from unforeseeable and foreseeable outages,

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			such as load shedding[47], to ensure that digital and mobile learning continues uninterruptedly.
	3.	Does the school have access to a reliable internet connection?	It is recommended that the school should have a reliable and secure internet connection, with a suitable data plan, to ensure that digital and mobile learning continues uninterruptedly without placing unnecessary stress on the teachers or learners.
	4.	Does the school have a networking for hardware and software in place?	It is recommended that schools should acquire suitable networking hardware and software to facilitate the integration between the digital learning platforms and the users (management, teachers, and learners).
	5.	Can the school provide internal training and support to assist with the implementation of digital and mobile learning?	It is recommended that the school should provide the necessary training and support to transfer skills and build the necessary internal capacity for the successful implementation of digital and mobile learning.
Technology Actant	1.	Does the technology provide access to the Internet with suitable data plans?	It is recommended that the school should provide the necessary infrastructure to ensure that all users (management, teachers, and learners) have reliable and secure internet access with the appropriate data plans.

[47] Load shedding refers to the deliberate shutdown of electric power in a part or parts of a power-distribution system, generally to prevent the failure of the entire system when the demand strains the capacity of the system (Dictionary.com, 2021).

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	2.	Is the hardware suitable for digital and mobile learning?	It is recommended that the school should provide (or provide recommendations for) suitable hardware for digital and mobile learning that includes the necessary features required for the various teaching subjects.
	3.	Is the software suitable for digital and mobile learning?	It is recommended that the school should provide (or provide recommendations for) suitable software for digital and mobile learning that includes the necessary features required for the various teaching subjects.
	4.	Can the hardware and software be integrated into a coherent networked system?	It is recommended that the technology should allow for all hardware and software components to be integrated into a coherent networked system. This should ensure that uninterrupted access to resources is provided, as well as offering the ability to monitor and report on all elements of the digital and mobile learning ecosystem timeously.
	5.	Does the technology implementation have support and maintenance plans or agreements in place?	It is recommended that all elements of the technology (all hardware and software components) should have a support and maintenance plan or agreement in place, to mitigate or solve any issues that might occur and ensure that digital and mobile learning continues uninterruptedly.

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Teacher Actant	1.	Do the teachers have access to the internet and suitable data plans?	It is recommended that teachers should have reliable internet access, with the appropriate data plans, both in their school and home teaching environments to ensure that digital and mobile learning continues uninterruptedly.
	2.	Do the teachers have access to suitable digital teaching devices?	It is recommended that teachers should have access to suitable hardware with features that can integrate into the wider digital and mobile learning ecosystem, as well as meet the requirements of digital and mobile teaching.
	3.	Do the teachers have access to suitable digital teaching software?	It is recommended that teachers should have access to suitable software with features that can integrate into the wider digital and mobile learning ecosystem, as well as meet the requirements of digital and mobile teaching.
	4.	Do the teachers have access to internal training and support?	It is recommended that teachers should have easy access to training and support resources to mitigate or solve any issues that might occur and ensure that digital and mobile learning continues uninterruptedly.
	5.	Do the teachers have access to conducive teaching environments?	It is recommended that teachers should be afforded suitable teaching environments for both in-class teaching and teaching remotely (should there be more COVID-19 lockdown restrictions).

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Learner Actant:	1.	Do the learners have access to the internet and suitable data plans?	It is recommended that learners should have reliable internet access, with the appropriate data plans, both at the school and in their home learning environment, to ensure that digital and mobile learning continues uninterruptedly.
	2.	Do the learners have access to suitable digital teaching devices?	It is recommended that learners should have access to suitable hardware with features that can integrate into the wider digital and mobile learning ecosystem, as well as meet the requirements of digital and mobile learning.
	3.	Do the learners have access to suitable digital teaching software?	It is recommended that learners should have access to suitable software with features that can integrate into the wider digital and mobile learning ecosystem, as well as meet the requirements of digital and mobile learning.
	4.	Do the learners have access to internal training and support?	It is recommended that learners should have easy access to training and support resources to mitigate or solve any issues that might occur and ensure that digital and mobile learning continues uninterruptedly.
	5.	Do the learners have access to conducive learning environments?	It is recommended that learners should be afforded suitable learning environments for both in-class learning and learning remotely (should there be more COVID-19 lockdown restrictions).

Phase 3 of the proposed framework (Figure 38) will consist of the 'Yes' / 'No' answers to the questions presented in Phase 2 (Table 12). Phase 3 will also act as a data capturing and

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evaluation point, where users of the proposed framework are offered an early overview of the school's preparedness for the implementation of digital and mobile learning. For this early overview, a 'High-level', 'Medium-level', and 'Low-level' scoring matrix has been developed based on the total number of 'Yes' answers on the Phase 2 questions. This score will, at its most basic level, give the user insight into the level of intervention required for the successful implementation of digital and mobile learning at the selected school, as seen in Table 13:

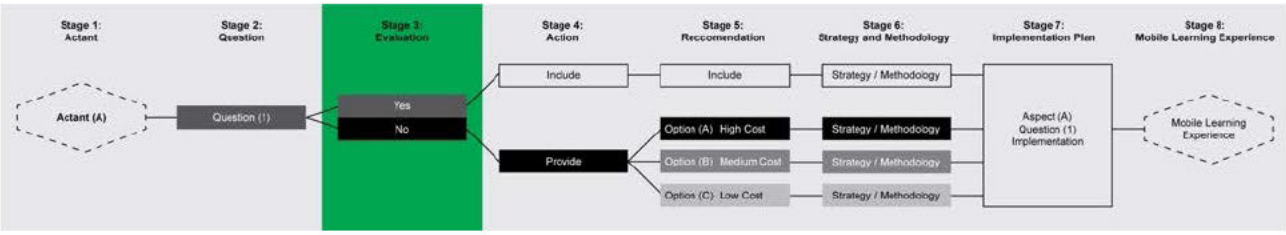

Figure 38: Framework overview - phase 3 (Erasmus, 2021).

Table 13: Phase 3 actant intervention score.

Score:	Level:	Description:
5 / 5	High-level score	A high-level score (5/5) will need little to no intervention in terms of the viability and capacity of the relevant digital and mobile learning implementation aspects.
4 / 5	Medium-level score	A medium-level score (3-4/5) will need a minor intervention in terms of the viability and capacity of the relevant digital and mobile learning implementation aspects.
3 / 5		
2 / 5	Low-level score	A low-level score (0-2/5) will need a major intervention in terms of the viability and capacity of the relevant digital and mobile learning implementation aspects.
1 / 5		
0 / 5		

It is important to note that a divergence exists at Phase 4 (Figure 39). Questions with a 'Yes' answer will move on directly to Phase 6, as there would be little to no need for actions to be taken (Phase 4) or recommendations to be provided (Phase 5). However, in the event of a 'No' answer, the process will continue to Phase 5 (Figure 40).

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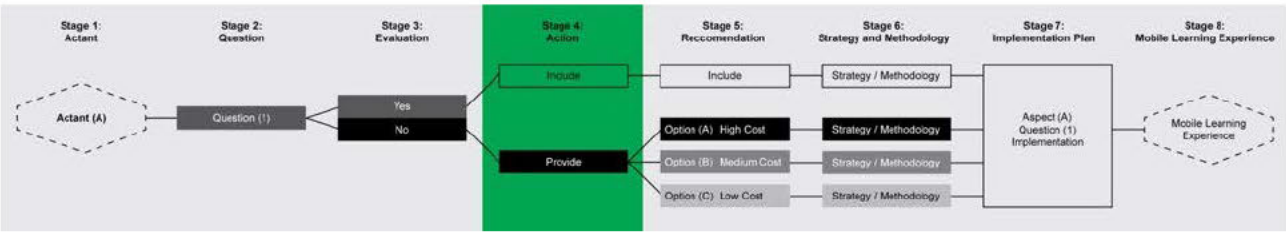

Figure 39: Framework overview - phase 4.

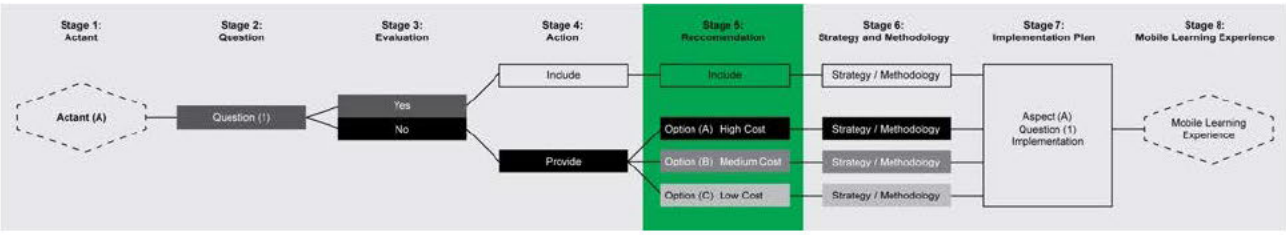

Figure 40: Framework overview - phase 5.

When the process reaches Phase 5, the data gathered will include: the actant, the question, the evaluation, as well as the action required. Questions that were answered with a 'No', will now receive three options of recommendation. These options include Option A, which is a high-cost / high-requirement option, Option B, which is an average-cost / average-requirement option, and Option C, which is a low-cost / low-requirement option. An example of these options is presented in Table 14, which lists high, average, and low-cost options for mobile learning pc-tablet devices.

Table 14: Example options of pc-tablets for mobile learning.

Option:	**Description:**
Option A: High-level / High-requirement	iPad Mini 6th Generation (iStore, 2021)

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	Cost:	R 9,299.00 (www.istore.co.za)
	Advantages:	High portability, long battery life, Apple Pencil compatible, high-level camera
	Disadvantages:	No 3.5mm audio jack
Option B: Medium-level / High-requirement	Samsung Galaxy Tab A7 (Samsung, 2021)	
	Cost:	R 4,999.00 (www.incredible.co.za)
	Advantages:	High portability, long battery life, S-Pen Stylus included
	Disadvantages:	Intermediate-level processing power
Option C: Low-level / High-requirement	Amazon Fire HD Tablet (Amazon, 2021)	
	Cost:	R 2,999.00 (www.geewis.co.za)
	Advantages:	High portability, low price

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	Disadvantages:	Poor screen quality, low-level processing power, locked into Amazon's digital software ecosystem

Once the user has selected the option based on their specific needs, the process will move to Phase 6 (Figure 41), which will respond to the selected option in the form of a strategy and methodology to implement the relevant actant. It is important to note that the questions answered 'Yes' will need to be reviewed at this stage to ensure that they align with the overall digital and mobile learning strategy.

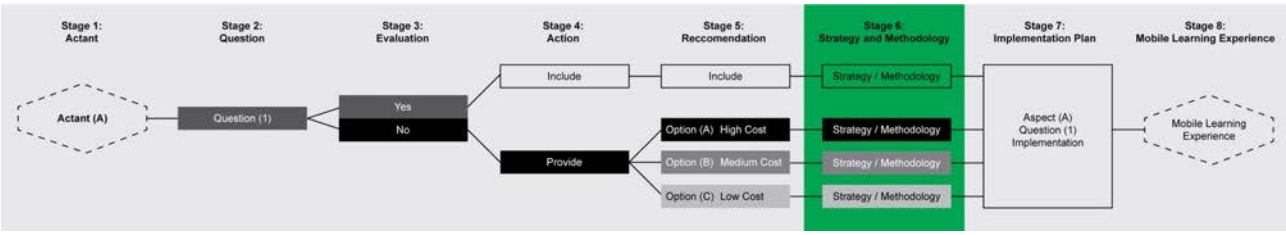

Figure 41: Framework overview - phase 6 (Erasmus, 2021).

Once the strategy and methodology have been drafted for the relevant actant, the process will then continue to Phase 7 (Figure 42), which will compile each actant's recommendation, strategy, and methodology into a coherent implementation plan for digital and mobile learning at the selected school.

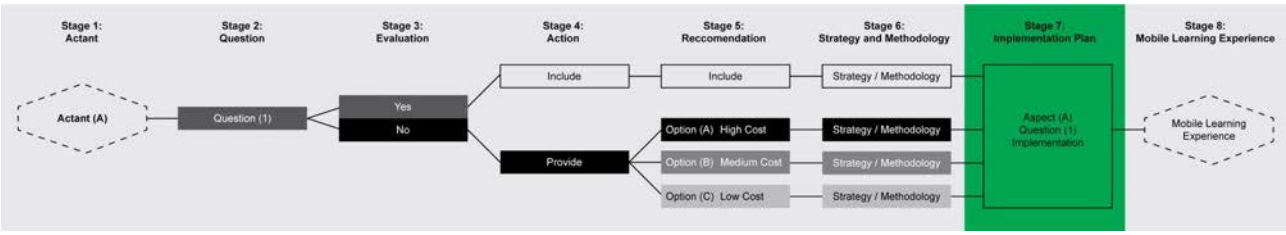

Figure 42: Framework overview - phase 7 (Erasmus, 2021).

The process has then reached Phase 8 (Figure 43), where a digital and mobile learning experience can be designed. It is important to note that the implementation plan, which would guide the design of the digital and mobile learning experience, should address the specific needs of the school, based on the user's inputs.

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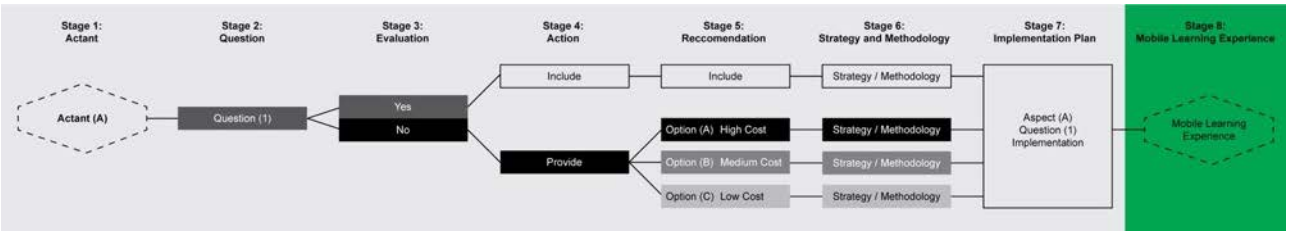

Figure 43: Framework overview - phase 8 (Erasmus, 2021).

5.2 Presentation of the Design Framework

The proposed framework for designing mobile learning experiences is presented in the form of a flow diagram[48], as seen in Figure 44, which illustrates the journey of a single actant from evaluation to implementation:

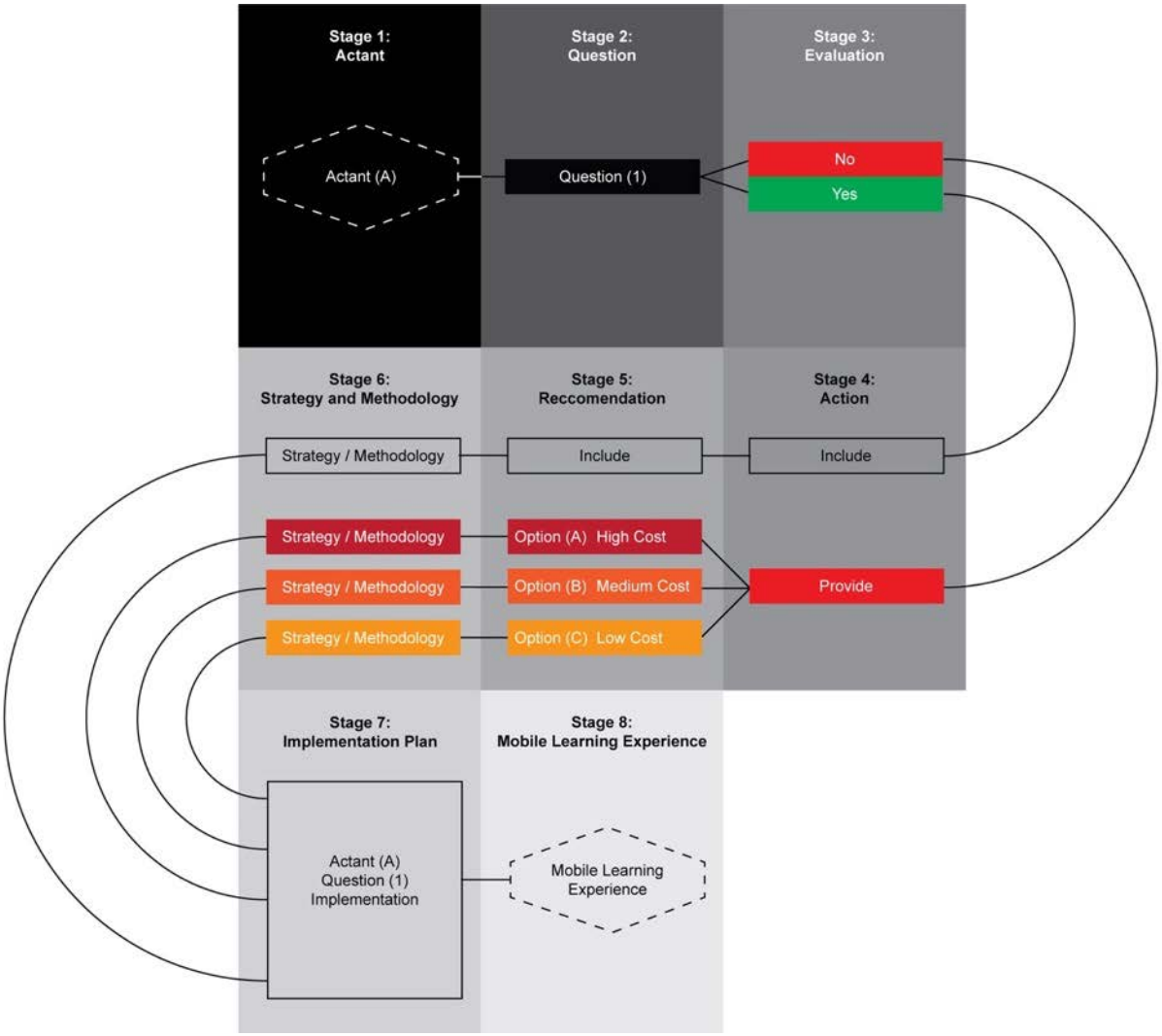

Figure 44: Framework as a flow diagram (Erasmus, 2021).

[48] A 'flow diagram' represents a sequence of movements or actions of people or things involved in a complex system or activity (Oxford Dictionary, 2021).

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To demonstrate an example, Question 2 of the Learner Actant (*Do the learners have access to suitable digital teaching devices?*) was evaluated, as seen in Figure 45. This example responded 'No' to Question 2 and selected Option C, the low-cost recommendation, which resulted in the Amazon Fire HD Tablet being offered as part of the mobile learning experience.

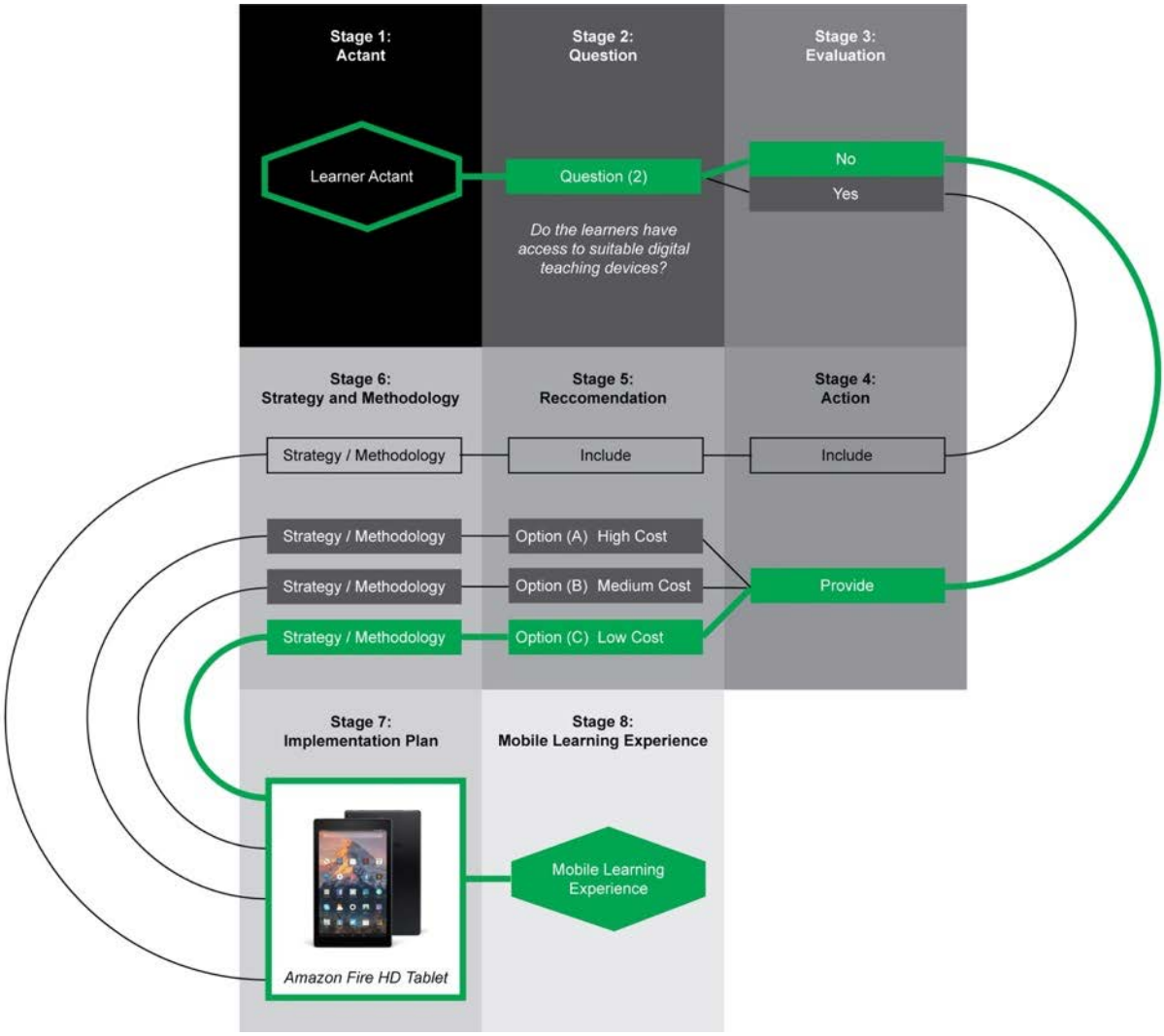

Figure 45: Question 2 of the learner actant implemented in the framework (Erasmus, 2021).

However, this example is merely one thread in the "ball of yarn" (Haraway, 1994), or 4 per cent of the total framework. The implementation plan, as proposed by this research, needs to evaluate five questions for at least five actants, which include: management, infrastructure, technology, teacher, and learner. To give an insight into the extent of extrapolation and how swiftly the framework can become more complex, Figure 46 is put

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forward, which provides a sectional view highlighting one (left) of the five actants (right) in the framework.

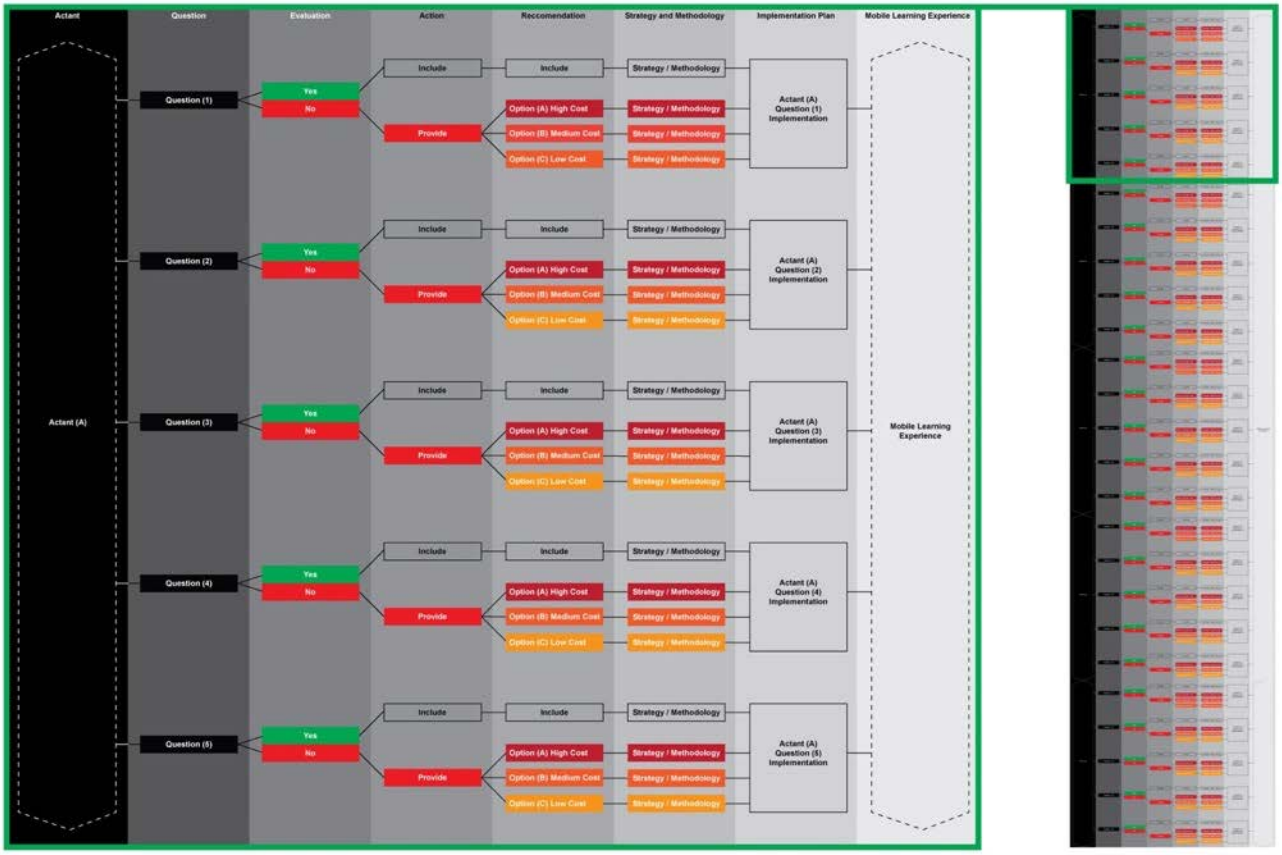

Figure 46: Framework overview, highlighting one of the five actants (Erasmus, 2021).

5.3 Discussion of the Design Framework

Even though the presented framework seems fairly structured, in terms of its linear processes and grid-like structure, it should be noted that the framework offers a strategy that is flexible and easily adaptable owing to its modular nature. What started as an entanglement of actants and agencies, is now slightly more structured owing to the process of "carefully studying particular strings and following these over time to see which relations the strings create" (Haraway, 1994). However, it is important to maintain the view of the theoretical perspective (sociomaterialism) and consider both the material and social aspects of any element.

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In order to test the framework in a practical sense, one would need to develop each of the seventy-five[49] recommendations, as well as their relevant strategies and methodologies. These would need to be developed within the context of South Africa in terms of available and applicable processes and technologies. As emphasised throughout the research, the framework needs to take into consideration the social, political, and economic factors of South Africa, especially those related to the management, infrastructure, technology, teacher, and learner actants.

The framework will also need to be made accessible to users who wish to establish the preparedness of their school, as well as what type of implementation will be most suitable for their design of a mobile learning experience. An execution of this, which is in development as a practical component of this research, will be a website-based activation of the framework on which users can conduct evaluations and simulations. Mock-ups of the proposed website-based activation are shown in Figures 47- 49:

[49] Calculation: (5 actants x 5 questions) x 3 options = 75 recommendations.

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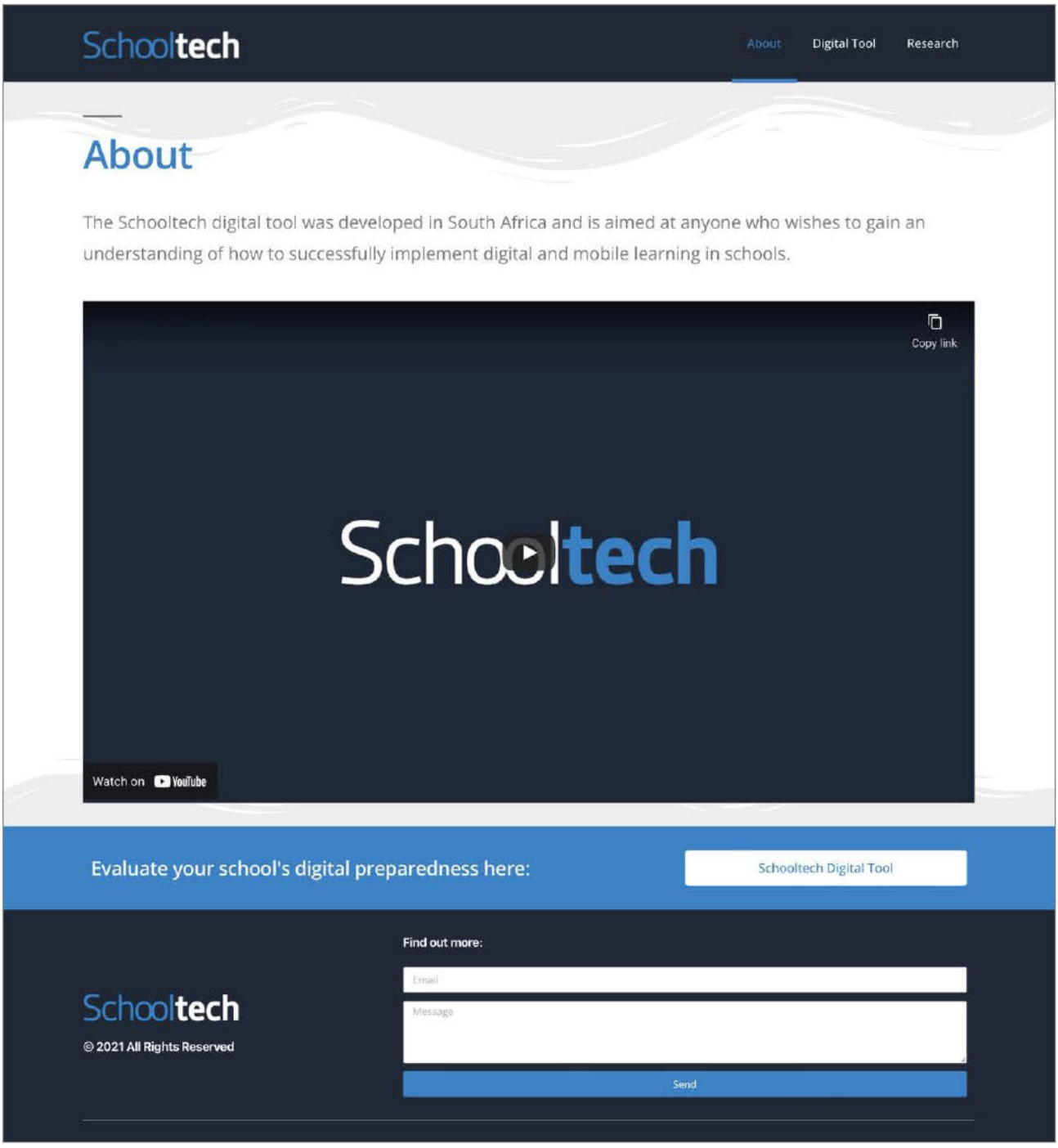

Figure 47: Assessment tool - test page mock-up (Erasmus, 2021).

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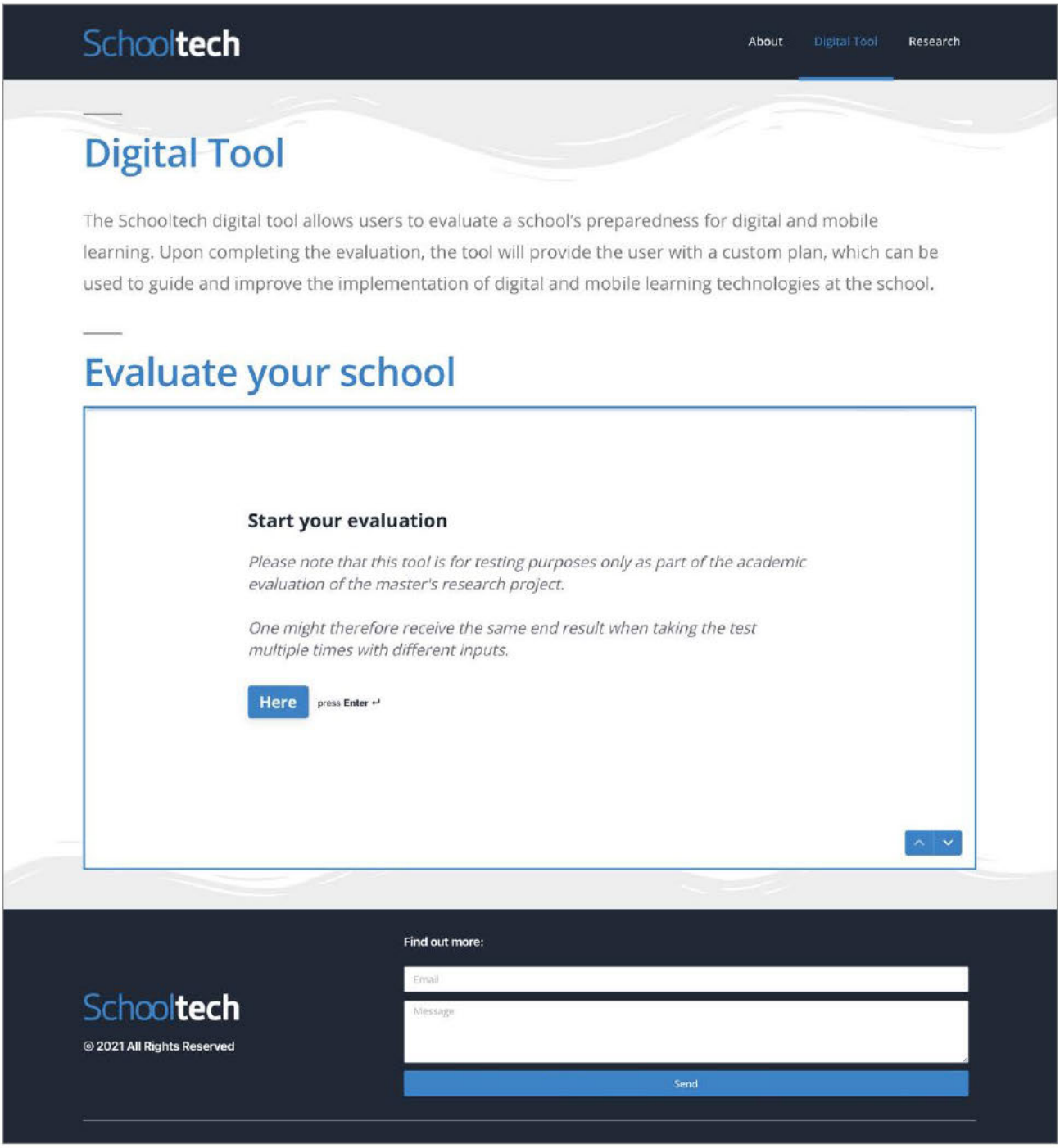

Figure 48: Assessment tool - question page mock-up (Erasmus, 2021).

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Figure 49: Assessment tool - download page mock-up (Erasmus, 2021).

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It is important to emphasise that the website-based activation of the framework, as presented in Figures 47-49, is by no measure a finalised product, but rather a packaged example that can be tested. It may very well be that the framework does not achieve the intended goal of providing a suitable implementation plan for the relevant school. In this case the framework will need to be redefined and refined through consultation with the participants or other stakeholders in an attempt to achieve this goal. However, as mentioned, it is considered preferable to provide solutions (or attempted solutions, in this case) that can be optimise and refined over time, instead of waiting for the perfect solution. The research process has therefore reached the 'test and refine' and 'talk less, do more' stages (Yeung, Lim & Rahman, 2018).

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Chapter 6: Conclusion

What possible framework for designing South African mobile learning experiences could be developed through a participatory design process?

In response to the research question stated at the beginning of this thesis, it is believed that the framework could potentially offer a viable strategy to guide the implementation of digital and mobile learning experiences that remains sensitive to the complex factors at play. The answer to the research question, is therefore proposed as:

An online tool that is sensitive to a complex range of sociomaterial agencies and can provide an implementation plan for digital and mobile learning experiences, which is guided by the factors related to the preparedness of the school.

6.1 Observations and Implications

The researcher would like to highlight three overall observations of the research study. The first observation is the lack of specific technology (hardware and software) discussed during the participatory design engagement. It was assumed that the discussions would centre around specific hardware and software issues, but instead the participants primarily discussed systems and processes. This reaffirms the notion that the challenges facing the implementation of digital and mobile learning lies within the social, political, and economic environments of South Africa. This was welcomed by the researcher as the aim of the research was to develop a framework that can potentially assist with the implementation of digital and mobile learning, and not an Apple vs Samsung debate.

Another critical observation made during the research process is the extent to which the teachers are bound by the management structures in place. It was evident that teachers do not see themselves as autonomous from the Department of Education and the school where they are employed. It required a considerable mind shift for them to be able to consider themselves independent from these structures. They continuously positioned themselves within hierarchal structures instead of a flattened perspective, which aligns with the ontological perspective in the study. This reaffirms the value in research that allows for a relational and entangled process, which can promote the awareness of the complexities thereof.

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The last observation was the unfortunate realisation about the mental health and wellbeing of teachers and learners. The teacher participants were extremely forthcoming about their personal challenges in terms of the stress and frustrations they faced (and are still facing) with the sudden shift to digital teaching and learning, such as the lack of training and support. The digital environment has blurred the lines between home time and school time, which has noticeably affected the teacher participants. This possibly reflects the reasons behind some of the failures in the implementation of digital and mobile learning in schools. As it is believed that under resourced teachers, who are not equipped with the skills to operate within the digital environment, are placed in a position where it is near impossible to achieve a level of success in the implementation of digital and mobile learning in schools.

The world has experienced a massive shift towards the digital environment since the start of this research in 2019 due to the global COVID-19 pandemic which reached South Africa in early March 2020. The level of relevance and importance could not have been predicted; nevertheless, but digital and mobile learning has now become the 'new normal'. Anderson, Rainie and Vogels (2021) predict that permanent change will be implemented by 2025, including the complete adoption of remote processes (remote working, virtual schooling, digital services), the prioritising of digital tools for convenience (smart consumer gadgets, digital education, digitally aligned living and working patterns), and unfortunately an increase in social ills (insular communities, increased spread of miscommunication, increase in mental health issues).

It is therefore critical that South Africa drastically improves its 'solutions' for digital and mobile learning. Even though there are many other challenges facing the youth, such as high rates of unemployment, poverty, mental health issues, HIV, and other physical health issues (Graham, 2019), we must remind ourselves that "education is the most powerful weapon which you can use to change the world" (Mandela, 1990).

6.2 Critique and Further Research Opportunities

There are two major critiques of this study. The first critique is that the research did not include learner participants. As mentioned, this was unfortunately not possible owing to the shifting school deadlines and pressures on learners as a result of the COVID-19 pandemic lockdowns in South Africa. However, because of the lack of links to the learner actant and the perceived lack of social agencies, as identified in the participatory design research

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engagement, it will be a critical next step to introduce learner participants in the study. One might then follow Participant-2's suggestions and conduct the same engagement twice more for comparison; a second time with learners only and a third time with learners and teachers. Furthermore, it is proposed that the selection criteria of future research participants include diversity in gender, race, language etc., in order to more closely reflect the diversity within South Africa.

Although the aim of the research was to develop a proposed framework, and not necessarily implement it, the second major critique of this study is the lack of framework testing. As the framework has been developed on a conceptual base, it still requires a process of testing and refinement. It is believed that when the tool is implemented across a diverse selection of schools, the researcher will be afforded the opportunity to engage with the social, political, and economic factors of South Africa on a deeper and more complex level. However, for this one would need to develop the seventy-five recommendations, as well as their relevant strategies and methodologies, which is a mammoth task in and of itself. Nevertheless, the framework is purposeless and impractical without these recommendations. One might also consider translating the framework into additional South African languages in order to make it more accessible to different users.

Based on these two major critiques, and reflecting on the potential significance of the research outcome, it is proposed that the study into the development of a framework for designing mobile learning experiences continues with a specific focus that aims to address the shortcomings of the research inputs (learner participants) and research outputs (the testing and refinement of the framework). The researcher believes that it is imperative that there is development of digital and mobile learning experiences that are relevant and meaningful to those who use them.

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(x) Epilogue

My research on the topic of developing a design framework for South African mobile learning experiences started in 2019 in response to the social, political and economic challenges which the public and private sectors are facing in their attempts to implement digital and mobile learning in schools. The driving force behind the implementation of these technologies in schools was the government and the private sector's commitment to meet the demands of the fourth industrial revolution. This need was, however, suddenly amplified owing to the global COVID-19 pandemic which resulted in a major uptake in various digital and mobile learning technologies and processes by educational institutions, teachers and learners.

In reflection to Maslow's saying: "...if the only tool you have is a hammer, to treat everything as if it were a nail" (1966:15), I hope that I have potentially developed a new tool for the mobile learning toolbox, which can help alleviate these challenges and set a course for a worthier future for the next generation.

This was my attempt.

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(xii) Addenda

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Addendum 2:	Research Approval by Eastern Cape Provincial Department of Education
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Addendum 5:	Opening the Cultural Probes Box
Addendum 6:	Invitations to Participate in Research Study
Addendum 7:	Written Consent for Individual Research Engagements
Addendum 8:	Participant Responses During Individual Research Engagements
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Addendum 11:	Written Consent for Participatory Design Research Engagements
Addendum 12:	Research Probes Submitted by Research Participants
Addendum 13:	Completed Participatory Design Diagram

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Addendum 1:

Research Approval by Research Ethics Committee

Reino Erasmus

Thesis presented in partial fulfilment
of the degree of Masters in Visual Arts
at the Visual Arts Department,
Faculty of Arts and Social Sciences
at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

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NOTICE OF APPROVAL

REC: Social, Behavioural and Education Research (SBER) - Initial Application Form

28 April 2020

Project number: 11048

Project Title: A framework for designing South African mobile learning experiences through a participatory design process.

Dear Mx Reino Erasmus

Your REC: Social, Behavioural and Education Research (SBER) - Initial Application Form submitted on 3 April 2020 was reviewed and approved by the REC: Social, Behavioural and Education Research (REC: SBE).

Please note below expiration date of this approved submission:

Ethics approval period:

Protocol approval date (Humanities)	Protocol expiration date (Humanities)
28 April 2020	27 April 2021

GENERAL COMMENTS:

1) There is currently a **postponement of all research activities at Stellenbosch University,** apart from research that can be conducted remotely/online and requires no human contact, and research in those areas specifically acknowledged as essential services by the South African government under the presidential regulations related to COVID-19 (e.g. clinical studies).

2) Remote (desktop-based/online) research activities, online analyses of existing data, and the writing up of research results are strongly encouraged in all SU research environments.

Please take note of the General Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

If the researcher deviates in any way from the proposal approved by the REC: SBE, the researcher must notify the REC of these changes.

Please use your SU project number (11048) on any documents or correspondence with the REC concerning your project.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

FOR CONTINUATION OF PROJECTS AFTER REC APPROVAL PERIOD

You are required to submit a progress report to the REC: SBE before the approval period has expired if a continuation of ethics approval is required. The Committee will then consider the continuation of the project for a further year (if necessary).

Once you have completed your research, you are required to submit a final report to the REC: SBE for review.

Included Documents:

Document Type	File Name	Date	Version
Research Protocol/Proposal	1_Erasmus_REC_Proposal	02/04/2020	V2
Recruitment material	4_Erasmus_Addendum_B_Invitation_to_Participate_in_Research_Study	02/04/2020	V2
Informed Consent Form	7_Erasmus_Addendum_E_Informed_Consent_Adults	02/04/2020	V2
Data collection tool	8_Erasmus_Addendum_F_Interview_Protocol	02/04/2020	V2
Data collection	9_Erasmus_Addendum_G_Workshop_Protocol	02/04/2020	V2

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tool		
Data collection tool	10_Erasmus_Addendum_H_Multimedia_Protocol	02/04/2020 V2
Proof of permission	12_Erasmus_Addendum_J_Permission_to_Conduct_Research_from_ECDOE	02/04/2020 V2
Default	2_Erasmus_Response_to_REC_Feedback	02/04/2020 V2
Default	14_Erasmus_Addendum_L_COVID-19_Protocol	02/04/2020 V2
Parental consent form	5_Erasmus_Addendum_C_Informed_Consent_Parental	02/04/2020 V2
Assent form	6_Erasmus_Addendum_D_Informed_Consent_Minors_Assent	02/04/2020 V2
Data collection tool	11_Erasmus_Addendum_I_Observation_Protocol	02/04/2020 V2
Request for permission	13_Erasmus_Addendum_K_Request_for_Permission_to_Conduct_Research_Gatekeeper	02/04/2020 V2
Default	3_Erasmus_Addendum_A_REC_Application_Complete	02/04/2020 V2

If you have any questions or need further help, please contact the REC office at cgraham@sun.ac.za.

Sincerely,

Clarissa Graham

REC Coordinator: Research Ethics Committee: Social, Behavioral and Education Research

National Health Research Ethics Committee (NHREC) registration number: REC-050411-032.
The Research Ethics Committee: Social, Behavioural and Education Research complies with the SA National Health Act No.61 2003 as it pertains to health research. In addition, this committee abides by the ethical norms and principles for research established by the Declaration of Helsinki (2013) and the Department of Health Guidelines for Ethical Research: Principles Structures and Processes (2nd Ed.) 2015. Annually a number of projects may be selected randomly for an external audit.

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Principal Investigator Responsibilities

Protection of Human Research Participants

As soon as Research Ethics Committee approval is confirmed by the REC, the principal investigator (PI) is responsible for the following:

Conducting the Research: The PI is responsible for making sure that the research is conducted according to the REC-approved research protocol. The PI is jointly responsible for the conduct of co-investigators and any research staff involved with this research. The PI must ensure that the research is conducted according to the recognised standards of their research field/discipline and according to the principles and standards of ethical research and responsible research conduct.

Participant Enrolment: The PI may not recruit or enrol participants unless the protocol for recruitment is approved by the REC. Recruitment and data collection activities must cease after the expiration date of REC approval. All recruitment materials must be approved by the REC prior to their use.

Informed Consent: The PI is responsible for obtaining and documenting affirmative informed consent using **only** the REC-approved consent documents/process, and for ensuring that no participants are involved in research prior to obtaining their affirmative informed consent. The PI must give all participants copies of the signed informed consent documents, where required. The PI must keep the originals in a secured, REC-approved location for at least five (5) years after the research is complete.

Continuing Review: The REC must review and approve all REC-approved research proposals at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period.** Prior to the date on which the REC approval of the research expires, **it is the PI's responsibility to submit the progress report in a timely fashion to ensure a lapse in REC approval does not occur.** Once REC approval of your research lapses, all research activities must cease, and contact must be made with the REC immediately.

Amendments and Changes: Any planned changes to any aspect of the research (such as research design, procedures, participant population, informed consent document, instruments, surveys or recruiting material, etc.), must be submitted to the REC for review and approval before implementation. Amendments may not be initiated without first obtaining written REC approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.

Adverse or Unanticipated Events: Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research-related injuries, occurring at this institution or at other performance sites must be reported to the REC within **five (5) days** of discovery of the incident. The PI must also report any instances of serious or continuing problems, or non-compliance with the RECs requirements for protecting human research participants.

Research Record Keeping: The PI must keep the following research-related records, at a minimum, in a secure location for a minimum of five years: the REC approved research proposal and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence and approvals from the REC.

Provision of Counselling or emergency support: When a dedicated counsellor or a psychologist provides support to a participant without prior REC review and approval, to the extent permitted by law, such activities will not be recognised as research nor the data used in support of research. Such cases should be indicated in the progress report or final report.

Final reports: When the research is completed (no further participant enrolment, interactions or interventions), the PI must submit a Final Report to the REC to close the study.

On-Site Evaluations, Inspections, or Audits: If the researcher is notified that the research will be reviewed or audited by the sponsor or any other external agency or any internal group, the PI must inform the REC immediately of the impending audit/evaluation.

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Addendum 2:

Research Approval by astern Cape Provincial Department of Education

Reino Erasmus

Thesis presented in partial fulfilment
of the degree of Masters in Visual Arts
at the Visual Arts Department,
Faculty of Arts and Social Sciences
at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

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Province of the
EASTERN CAPE
EDUCATION

STRATEGIC PLANNING POLICY RESEARCH AND SECRETARIAT SERVICES
Steve Vukile Tshwete Complex • Zone 6 • Zwelitsha • Eastern Cape
Private Bag X0032 • Bhisho • 5605 • REPUBLIC OF SOUTH AFRICA
Tel: +27 (0)40 608 4691/4773 • Fax: +27 (0)86 742 4942 • Website: www.ecdoe.gov.za

Enquiries: B Pamla Email: babalwa.pamla@ecdoe.gov.za Date: 02 December 2019

Mr. Reino Erasmus

95 Butterflied Road

Little Chelsa

Port Elizabeth

6001

Dear Mr. R Erasmus

PERMISSION TO UNDERTAKE MASTERS STUDY:A FRAMEWORK FOR DESIGNING SOUTH AFRICAN MOBILE LEARNIG EXPERIENCES THROUGH A PARTICIPATORY DESGN PROCESS

1. Your application to conduct the above mentioned research involving 04 learners, 04 educators and 4 schools in the jurisdiction of Nelson Mandela Bay of the Eastern Cape Department of Education (ECDoE) is hereby approved based on the following conditions:

    a. there will be no financial implications for the Department;

    b. you will make all necessary arrangement concerning your research;

    c. institutions and respondents must not be identifiable in any way from the results of the investigation;

    d. all ethical considerations are adhered to;

    e. you seek parents' consent for minors;

    f. it is not going to interrupt educators' time and task;

    g. the research may not be conducted during official contact time, including school breaks, but an arrangement to do research at the school after school hours may be arranged and agreed upon in writing with the Principal and the affected teacher/s;

    h. you present a copy of the written approval letter of the Eastern Cape Department of Education (ECDoE) to the Cluster and District Directors before any research is undertaken at any institutions within that particular district;

PGDP EASTERN CAPE

Ikamva eliqaqambileyo!

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i. should you wish to extend the period of research after approval has been granted, an application to do this must be directed to Chief Director: Strategic Management Monitoring and Evaluation;

j. your research will be limited to those institutions for which approval has been granted, should changes be effected written permission must be obtained from the Chief Director: Strategic Management Monitoring and Evaluation;

k. you present the Department with a copy of your final paper/report/dissertation/thesis free of charge in hard copy and electronic format. This must be accompanied by a separate synopsis (maximum 2 – 3 typed pages) of the most important findings and recommendations if it does not already contain a synopsis.

l. you present the findings to the Research Committee and/or Senior Management of the Department when and/or where necessary.

m. you are requested to provide the above to the Chief Director: Strategic Management Monitoring and Evaluation upon completion of your research.

n. you comply with all the requirements as completed in the Terms and Conditions to conduct Research in the ECDoE document duly completed by you.

o. you comply with your ethical undertaking (commitment form)

p. You submit on a six monthly basis, from the date of permission of the research, concise reports to the Chief Director: Strategic Management Monitoring and Evaluation

2. The Department reserves a right to withdraw the permission should there not be compliance to the approval letter and contract signed in the Terms and Conditions to conduct Research in the ECDoE.

3. The Department will publish the completed Research on its website.

4. The Department wishes you well in your undertaking. You can contact the Director, Ms. NY Kanjana on the numbers indicated in the letterhead or email nelisa.kanjana@ecdoe.gov.za should you need any assistance.

NY KANJANA
DIRECTOR: STRATEGIC PLANNING POLICY AND RESEARCH

FOR SUPERINTENDENT-GENERAL: EDUCATION

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Addendum 3:
COVID-19 Research Protocol

Reino Erasmus

Thesis presented in partial fulfilment
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at the Visual Arts Department,
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at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

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COVID-19 RESEARCH PROTOCOL

The following COVID-19 Protocol undersigned by Prof. Len Hansen and published on behalf of the Research Ethics Committee (Social, Behavioural and Education Research) on the 20th of March 2020 will be used to guide the research process.

Taking into consideration the principle of *primum non nocere* or 'first do no harm', the REC: SBE carefully considered a reasonable ethical justification for social science, behavioural and education (SBE) research to continue, specifically research that involves physical contact or being in undue physical proximity to research participants (Herewith referring to face-to-face individual or group interviews or activities where physical contact is unavoidable), without the prospect direct benefit that could outweigh the potential harm of COVID-19 infection.

Note that the prospect of direct participant benefit applies primarily to certain types of clinical research and is unlikely to apply in a social, behavioural or educational research context.

Considering the state of national disaster and aligning itself with the call from national health authorities and experts to practice social distancing, the REC: SBE has made the following immediate decisions with respect to existing and new human research:

1. All REC: SBE-approved research (low, medium and high risk), that involve physical contact or being in undue physical proximity to human participants, must be postponed until further notice unless there are very exceptional reasons to not postpone such research. SBE research and visits at the following research sites must be suspended with immediate effect considering the social distancing protocols put in place by national authorities: Correctional Centres, Detention Facilities, Holding Cells, Military Detention Facilities, Department of Social Development facilities,

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healthcare facilities, universities, schools and early childhood development centres (EDCs).

2. Research activities and studies that do not involve physical contact or being in undue physical proximity with participants or communities may continue as these do not pose a potential risk of harm of COVID-19 infection. These activities include desktop research, literature reviews, secondary data analysis, online or virtual data collection activities, individual or group interviews conducted via online meeting or web conferencing tools, such as Skype or Microsoft Teams.
3. Researchers who are unable to postpone their data collection activities (in the case of scenario 1) are encouraged to explore whether data collection can be done in a manner that does not require physical contact or being in undue physical proximity with participants i.e. interviews via Skype, WhatsApp, or other online or web-based platforms. Researchers who can revise their data collection activities in this way must submit an urgent amendment to the REC: SBE for review and approval. Researchers can consult
4. In the exceptional cases where physical contact or being in undue physical proximity with participants and communities are essential (as described in scenario 1), the researcher must notify the REC: SBE immediately and provide ethical justification for the research to continue. The researcher will be required to submit a strategy for mitigation to ensure that risks of transmission are minimised and controlled. The REC: SBE will require those researchers to submit an amendment to the REC for urgent committee review and approval.
5. The REC: SBE would like to encourage researchers who are bound by funding or other contractual deadlines/requirements to proactively engage with their funders, sponsors and other relevant project stakeholders on the impact that COVID-19 and social distancing strategies will have on meeting project milestones and reporting deadlines. The suspension of human research that involve physical contact will have particular impact on existing contractual and service level agreements with research assistants, fieldworkers and other project staff. Where possible, researchers should engage with the funder/sponsor/relevant stakeholders regarding these timeframes and make the necessary arrangements.

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Please note the following notices regarding the functioning of the REC: SBE during the COVID-19 pandemic:

The REC will continue to review new and continuing review submissions made to the REC. However, a moratorium will be placed on the approval of new submissions that involve physical contact or being in undue physical proximity with human participants (see scenario 1). This moratorium will be lifted after social distancing protocols are relaxed by national authorities. Researchers who have yet to apply for ethics clearance must prepare a statement on the strategies and mitigations that will be put in place during the COVID-19 pandemic. This is considered a risk of harm for all research that involves physical contact or being in undue physical proximity human participants and must be considered and discussed in the research proposal for the foreseeable future.

This moratorium will not apply to research described in scenario 2 i.e. desktop research, literature reviews, secondary data analysis, online or virtual data collection activities, individual or group interviews conducted via online meeting or web conferencing tools, such as Skype or Microsoft Teams.

The REC: SBE (and by extension the DESCs) will prioritise the review of amendments (following the REC's decision made in points 3 and 4), unanticipated events, serious adverse events and protocol deviations.

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Addendum 4:

Critical Research Questions

Reino Erasmus

Thesis presented in partial fulfilment
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at the Visual Arts Department,
Faculty of Arts and Social Sciences
at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

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List of Critical Research Questions:

1.	Who …	… are the key stakeholders? … are the industry decision makers? … are mostly affected by this? … needs to benefit from this?
2.	What …	… are the pros and cons of this? … are the most and least important factors? … is another perspective on this? … is the alternative to this?
3.	Why …	… is there a problem of challenge? … is it relevant to me or others? … is there a need for this in society? … are people influenced by this?
4.	Where …	… is the biggest need for this? … are similar concepts being implemented? … are the areas of improvement? … will this concept take us?
5.	How …	… is this similar to something else? … does this disrupt the status quo? … can this harm or benefit society? … do we see this in the future?
6.	When …	… would this benefit our society? … could this cause a problem? … is the best time to take action? … can we expect this to change?

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Addendum 5:
Opening the Cultural Probes Box

Reino Erasmus

Thesis presented in partial fulfilment
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Faculty of Arts and Social Sciences
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Supervisor: Dr. Karolien Perold-Bull

April 2022

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Opening the Cultural Probes Box.

Table 1 is an analysis of each of the research probes put forward in the research by Thoring, Luippold & Mueller (2013), as seen in in Figure 1.

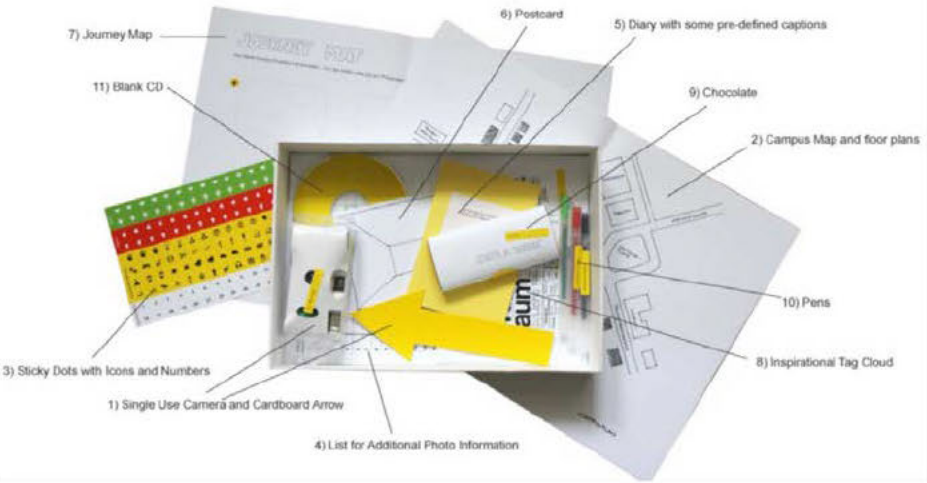

Figure 1: Opening the Cultural Probes Box (Thoring, Luippold & Mueller 2013)

Table 1: Analysis of Thoring, Luippold & Mueller's Cultural Probes Box.

Item:	Reflection:
Box:	It is highly possible that there will not exist a need for such an item during the research. The proposed workshops, which will be held in-person or digitally, will be scheduled in a venue with a sufficient writing surface.
Sketchbook:	Sketchbooks can definitely ease the method of recording notes and illustration throughout the research process. These can be utilised individually or scaled up to a larger format (A3 or A2 paper-size) to accommodate collaborative note making.
Site and Floorplans:	Instead of a sitemap or floorplan, a geographical map of the Eastern Cape can potentially assist the researcher and

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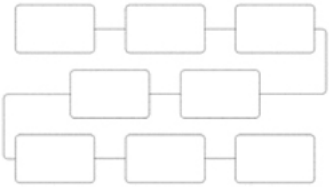
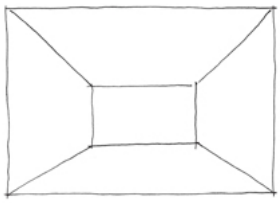
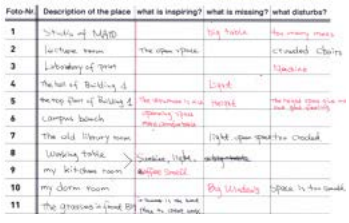
	workshop participants to gain an oversight of the social, economic and political elements tied to the different geographic areas in the province.
Journey Map: 	A 'journey map' can be and effective tool to document the development and refinement of the proposed framework for designing mobile learning experiences. It can also assist to guide the researcher and workshop participants through the process of enquiry and document how the discussion expands.
Postcard to Grandma: 	Metaphoric- or cultural references are even more nuanced in South Africa, which is considered to be a melting-pot of language and culture. Therefore, it would not be recommended to include probes that rely on the intrinsic knowledge or references of a particular group, culture or language.
Disposable Camera:	The film photography industry has seen a major decline since the increase in digital photography. This decrease in demand as increased the cost and availability of negative film development and is therefore not recommended as a possible probe within this context. Digital (mobile) photography is far more accessible and flexible at this point.
Photo List: 	It is highly possible that there will not exist a need for such an item during the research. More suitable probes, such as the notebook, can be utilised more effectively.

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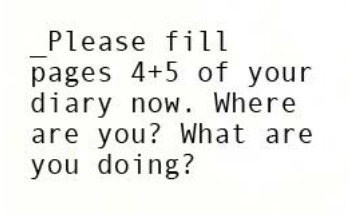
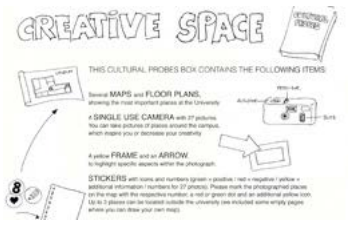
Stickers:	Stickers may indeed help structure, contextualise and add additional meaning when used in conjunction with writing-based probes, such as a notebook.
Text Message: 	When taking into consideration the participants identified for the workshops (learners, teachers and design professionals), it is highly likely that random text message may disturb these participants and might suffer the same consequences as Thoring, Luippold & Mueller's study has shown.
Chocolate:	Refreshments and snacks will be made available at the participatory design workshops to help promote positive thinking.
Instructions: 	Instructional resources can assist the participant who might not understand the function or use of the probe. However, it is crucial that these instructions do not lead the participants' actions or the research in any way.
Tag Cloud:	As with the stickers, a visual resource may indeed help structure, contextualise and add additional meaning when used in conjunction with writing-based probes, such as a notebook.

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Frame and Arrow:	As with the tag cloud and stickers, a visual resource may indeed help structure, contextualise and add additional meaning when used in conjunction with other probes, such as a notebook or a camera.
Blank CD:	As seen with the study, the CD was not utilised in a meaningful way. The likelihood that this will be reflected in a South African context is high, especially as it requires the use of a computer. An alternative option would be the use of a flash-drive, which it more accessible and has greater storage capacity. But the use is yet to be determined relevant.
Pens:	Within the context of the participatory design workshops, coloured pens could potentially improve the communication and documentation methods, as they can provide basic visual cues, which can represent the process or results of probing e.g. green for approved directions and red for disapproved directions.

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Addendum 6:

Invitations to Participate in Research Study

Reino Erasmus

Thesis presented in partial fulfilment
of the degree of Masters in Visual Arts
at the Visual Arts Department,
Faculty of Arts and Social Sciences
at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

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INVITATION TO PARTICIPATE IN RESEARCH STUDY

INDIVIDUAL INTERVIEW

Dear Participant-1 (*Name Withheld*)

Thank you for the support and insights provided in our previous engagements for my research on the topic of mobile learning in South Africa.

As you know, nearly all sectors of society have experienced a sudden shift to digital, caused by the COVID-19 pandemic, which has increased the relevance and need for research in this area.

As you are an experienced educator, I will be very interested in hearing your thoughts on the current state and possible future of mobile learning in South Africa.

It is on that point that I would like to kindly invite you to a short 30-min appointment to discuss the topic in more detail from your professional viewpoint, which will greatly assist in the completion of my master's project.

Should you accept this invitation, may I ask that you please indicate an availability of time and place at your convenience between Friday 13 November to Friday 20 November.

Kind Regards,

Reino Erasmus

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INVITATION TO PARTICIPATE IN RESEARCH STUDY

INDIVIDUAL INTERVIEW

Dear Participant-2 (*Name Withheld*)

I received your contact information from Greig Timkoe, who is a participant in my research study on the topic of mobile learning in South Africa. He mentioned that you might be willing to partake in the study as you show a keen interest in educational technologies.

As you know, nearly all sectors of society have experienced a sudden shift to digital, caused by the COVID-19 pandemic, which has increased the relevance and need for research in this area.

As you are an experienced educator, I will be very interested in hearing your thoughts on the current state and possible future of mobile learning in South Africa.

It is on that point that I would like to kindly invite you to a short 30-min appointment to discuss the topic in more detail from your professional viewpoint, which will greatly assist in the completion of my master's project.

Should you accept this invitation, may I ask that you please indicate an availability of time and place at your convenience between Friday 13 November to Friday 20 November.

Kind Regards,

Reino Erasmus

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INVITATION TO PARTICIPATE IN RESEARCH STUDY

INDIVIDUAL INTERVIEW

Dear Participant-3 (*Name Withheld*)

Thank you for the support and insights provided in our previous engagements for my research on the topic of mobile learning in South Africa.

As you know, nearly all sectors of society have experienced a sudden shift to digital, caused by the COVID-19 pandemic, which has increased the relevance and need for research in this area.

As you are an industry expert in the flied of Software and Systems Analysis, I will be very interested in hearing your thoughts on the current state and possible future of mobile learning in South Africa.

It is on that point that I would like to kindly invite you to a short 30-min appointment to discuss the topic in more detail from your professional viewpoint, which will greatly assist in the completion of my master's project.

Should you accept this invitation, may I ask that you please indicate an availability of time and place at your convenience between Friday 13 November to Friday 20 November.

Kind Regards,

Reino Erasmus

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INVITATION TO PARTICIPATE IN RESEARCH STUDY

INDIVIDUAL INTERVIEW

Dear Participant-4 (*Name Withheld*)

Thank you for the support and insights provided in our previous engagements for my research on the topic of mobile learning in South Africa.

As you know, nearly all sectors of society have experienced a sudden shift to digital, caused by the COVID-19 pandemic, which has increased the relevance and need for research in this area.

As you are an industry expert in the flied of Software Development, I will be very interested in hearing your thoughts on the current state and possible future of mobile learning in South Africa.

It is on that point that I would like to kindly invite you to a short 30-min appointment to discuss the topic in more detail from your professional viewpoint, which will greatly assist in the completion of my master's project.

Should you accept this invitation, may I ask that you please indicate an availability of time and place at your convenience between Friday 13 November to Friday 20 November.

Kind Regards,

Reino Erasmus

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INVITATION TO PARTICIPATE IN RESEARCH STUDY

INDIVIDUAL INTERVIEW

Dear Participant-5 (*Name Withheld*)

Thank you for the support and insights provided in our previous engagements for my research on the topic of mobile learning in South Africa.

As you know, nearly all sectors of society have experienced a sudden shift to digital, caused by the COVID-19 pandemic, which has increased the relevance and need for research in this area.

As you are an industry expert in the flied of Facilitation and Training, I will be very interested in hearing your thoughts on the current state and possible future of mobile learning in South Africa.

It is on that point that I would like to kindly invite you to a short 30-min appointment to discuss the topic in more detail from your professional viewpoint, which will greatly assist in the completion of my master's project.

Should you accept this invitation, may I ask that you please indicate an availability of time and place at your convenience between Friday 13 November to Friday 20 November.

Kind Regards,

Reino Erasmus

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Addendum 7:

Written Consent for Individual Research Engagements

Reino Erasmus

Thesis presented in partial fulfilment
of the degree of Masters in Visual Arts
at the Visual Arts Department,
Faculty of Arts and Social Sciences
at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

Stellenbosch University https://scholar.sun.ac.za

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CONSENT TO PARTICIPATE IN RESEARCH

INDIVIDUAL INTERVIEW

Dear Participant-1 (*Name Withheld*)

Preliminary research into the field of mobile learning applications in Nelson Mandela Bay has identified you as a key stakeholder for consultation. You have therefore been asked to participate in a research study into this field.

The research will be conducted by Mr. Reino Erasmus, who is currently a master's student at the Department of Visual Arts at the Stellenbosch University. His research paper aims to gain a deeper understanding in the development of mobile learning experiences within the South African content.

Participants of this study will be asked to do the following;

1. Participate in a 30-min interview where they will be asked to respond to questions, or engage in activities related to mobile learning experiences.
2. Allow the researcher to document the interviews and/or facilitated workshops by means of transcription, photography, video recording and/or audio recordings.
3. Allow the researcher to use the information gathered in a research study.

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Please note the following Terms and Conditions:

a) In light of the active coronavirus pandemic, no participants will be asked to engage in-person with the researcher or other participants until such time that the South African government lifts the restrictions currently in place. However, it is important to note that participants will always have the option to participate virtually through digital communication technologies, such as Skype, Zoom, WhatsApp Video Call, FaceTime etc.
b) Participants will not directly benefit from this study or receive any payment. The research paper is aimed at the benefit of society by attempting to alleviate some the challenges the education sector is facing with the implementation of "digital" and "paperless" classrooms.
c) The confidentiality and privacy of all participants will be strictly maintained as required by law. The research paper will not publish any personal information; nor will the researcher disclose any personal information gained through this study.
d) Participants are allowed to withdraw from this study at any time without consequences of any kind. Participants may also refuse to answer any questions during the interview process or refuse to partake in any of the activities during the facilitated workshops. In this event, the researcher will formally acknowledge this withdrawal and remove, delete and/or destroy all information gained from the participant.
e) All data gathered will be kept securely as per the policies and procedures set by Stellenbosch University's Research Ethics Committee. Participants may request, review and/or edit any and all data gathered during their engagements with the researcher. All data will be kept for a period of 5-years after the publication of the research paper to allow adequate time for formal reportage of results where after it will be deleted.
f) Should any concerns arise, you may contact the researcher Mr. Reino Erasmus [erasmus.re@gmail.com, 067 687 6448] or the research supervisor: Dr. Karolien Perold [karolien@sun.ac.za, 021 808 3046] directly.
g) Participants are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms. Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

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DECLARATION OF CONSENT BY PARTICIPANT

I hereby acknowledge that the information disclosed in this consent form was described to me, by Mr. Reino Erasmus in English and that I am in command of this language or it was satisfactorily translated to me. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

I hereby consent voluntarily to participate in this study.

(*Name Withheld*)
Name of Participant

Signature of Participant

13 November 2020
Date

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CONSENT TO PARTICIPATE IN RESEARCH

INDIVIDUAL INTERVIEW

Dear Participant-2 (*Name Withheld*)

Preliminary research into the field of mobile learning applications in Nelson Mandela Bay has identified you as a key stakeholder for consultation. You have therefore been asked to participate in a research study into this field.

The research will be conducted by Mr. Reino Erasmus, who is currently a master's student at the Department of Visual Arts at the Stellenbosch University. His research paper aims to gain a deeper understanding in the development of mobile learning experiences within the South African content.

Participants of this study will be asked to do the following;

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3. Allow the researcher to use the information gathered in a research study.

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DECLARATION OF CONSENT BY PARTICIPANT

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I hereby consent voluntarily to participate in this study.

(*Name Withheld*)
Name of Participant

Signature of Participant

24 November 2020
Date

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CONSENT TO PARTICIPATE IN RESEARCH

INDIVIDUAL INTERVIEW

Dear Participant-3 (*Name Withheld*)

Preliminary research into the field of mobile learning applications in Nelson Mandela Bay has identified you as a key stakeholder for consultation. You have therefore been asked to participate in a research study into this field.

The research will be conducted by Mr. Reino Erasmus, who is currently a master's student at the Department of Visual Arts at the Stellenbosch University. His research paper aims to gain a deeper understanding in the development of mobile learning experiences within the South African content.

Participants of this study will be asked to do the following;

1. Participate in a 30-min interview where they will be asked to respond to questions, or engage in activities related to mobile learning experiences.
2. Allow the researcher to document the interviews and/or facilitated workshops by means of transcription, photography, video recording and/or audio recordings.
3. Allow the researcher to use the information gathered in a research study.

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DECLARATION OF CONSENT BY PARTICIPANT

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I hereby consent voluntarily to participate in this study.

(*Name Withheld*)
Name of Participant

Signature of Participant

13 November 2020
Date

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CONSENT TO PARTICIPATE IN RESEARCH

INDIVIDUAL INTERVIEW

Dear Participant-4 (*Name Withheld*)

Preliminary research into the field of mobile learning applications in Nelson Mandela Bay has identified you as a key stakeholder for consultation. You have therefore been asked to participate in a research study into this field.

The research will be conducted by Mr. Reino Erasmus, who is currently a master's student at the Department of Visual Arts at the Stellenbosch University. His research paper aims to gain a deeper understanding in the development of mobile learning experiences within the South African content.

Participants of this study will be asked to do the following;

1. Participate in a 30-min interview where they will be asked to respond to questions, or engage in activities related to mobile learning experiences.
2. Allow the researcher to document the interviews and/or facilitated workshops by means of transcription, photography, video recording and/or audio recordings.
3. Allow the researcher to use the information gathered in a research study.

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f) Should any concerns arise, you may contact the researcher Mr. Reino Erasmus [erasmus.re@gmail.com, 067 687 6448] or the research supervisor: Dr. Karolien Perold [karolien@sun.ac.za, 021 808 3046] directly.
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DECLARATION OF CONSENT BY PARTICIPANT

I hereby acknowledge that the information disclosed in this consent form was described to me, by Mr. Reino Erasmus in English and that I am in command of this language or it was satisfactorily translated to me. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

I hereby consent voluntarily to participate in this study.

(*Name Withheld*)
Name of Participant

Signature of Participant

18 November 2020
Date

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CONSENT TO PARTICIPATE IN RESEARCH

INDIVIDUAL INTERVIEW

Dear Participant-5 (*Name Withheld*)

Preliminary research into the field of mobile learning applications in Nelson Mandela Bay has identified you as a key stakeholder for consultation. You have therefore been asked to participate in a research study into this field.

The research will be conducted by Mr. Reino Erasmus, who is currently a master's student at the Department of Visual Arts at the Stellenbosch University. His research paper aims to gain a deeper understanding in the development of mobile learning experiences within the South African content.

Participants of this study will be asked to do the following;

1. Participate in a 30-min interview where they will be asked to respond to questions, or engage in activities related to mobile learning experiences.
2. Allow the researcher to document the interviews and/or facilitated workshops by means of transcription, photography, video recording and/or audio recordings.
3. Allow the researcher to use the information gathered in a research study.

Stellenbosch University https://scholar.sun.ac.za

Please note the following Terms and Conditions:

a) In light of the active coronavirus pandemic, no participants will be asked to engage in-person with the researcher or other participants until such time that the South African government lifts the restrictions currently in place. However, it is important to note that participants will always have the option to participate virtually through digital communication technologies, such as Skype, Zoom, WhatsApp Video Call, FaceTime etc.
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g) Participants are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms. Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

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DECLARATION OF CONSENT BY PARTICIPANT

I hereby acknowledge that the information disclosed in this consent form was described to me, by Mr. Reino Erasmus in English and that I am in command of this language or it was satisfactorily translated to me. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

I hereby consent voluntarily to participate in this study.

(*Name Withheld*)
Name of Participant

Signature of Participant

18 November 2020
Date

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Addendum 8:
Participant Responses During Individual Research Engagements

Reino Erasmus

Thesis presented in partial fulfilment
of the degree of Masters in Visual Arts
at the Visual Arts Department,
Faculty of Arts and Social Sciences
at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

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INTERVIEW SCHEDULE

Time and Date:	13 November 2020 @ 10am		
Venue:	(*Address Withheld*)		
Participant:	(*Name Withheld*)		
Participant Code:	1	**Profession**:	Educator

The researcher must read the following terms to the participant and may only proceed once the participant has approved the process:

1. The participant has signed the relevant Informed Consent Form.
2. The participant has given the researcher permission to record the interview by means of transcription, photography, videography and/or audio recordings.
3. The participant has given the researcher permission to use the information gathered in a research study.
4. The participant knows that they can withdraw from the study at any point or refuse to answer any questions without consequences of any kind.

Signature of Participant Signature of Researcher

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INTERVIEW SCHEDULE

Time and Date:	24 November 2020 @ 9am		
Venue:	(*Address Withheld*)		
Participant:	(*Name Withheld*)		
Participant Code:	2	**Profession**:	Educator

The researcher must read the following terms to the participant and may only proceed once the participant has approved the process:

1. The participant has signed the relevant Informed Consent Form.
2. The participant has given the researcher permission to record the interview by means of transcription, photography, videography and/or audio recordings.
3. The participant has given the researcher permission to use the information gathered in a research study.
4. The participant knows that they can withdraw from the study at any point or refuse to answer any questions without consequences of any kind.

Signature of Participant Signature of Researcher

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INTERVIEW SCHEDULE

Time and Date:	13 November 2020 @ 2pm		
Venue:	(*Address Withheld*)		
Participant:	(*Name Withheld*)		
Participant Code:	3	**Profession**:	Software Analyst

The researcher must read the following terms to the participant and may only proceed once the participant has approved the process:

1. The participant has signed the relevant Informed Consent Form.
2. The participant has given the researcher permission to record the interview by means of transcription, photography, videography and/or audio recordings.
3. The participant has given the researcher permission to use the information gathered in a research study.
4. The participant knows that they can withdraw from the study at any point or refuse to answer any questions without consequences of any kind.

Signature of Participant Signature of Researcher

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INTERVIEW SCHEDULE

Time and Date:	18 November 2020 @ 11am		
Venue:	(*Address Withheld*)		
Participant:	(*Name Withheld*)		
Participant Code:	4	**Profession**:	Software Developer

The researcher must read the following terms to the participant and may only proceed once the participant has approved the process:

1. The participant has signed the relevant Informed Consent Form.
2. The participant has given the researcher permission to record the interview by means of transcription, photography, videography and/or audio recordings.
3. The participant has given the researcher permission to use the information gathered in a research study.
4. The participant knows that they can withdraw from the study at any point or refuse to answer any questions without consequences of any kind.

Signature of Participant Signature of Researcher

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INTERVIEW SCHEDULE

Time and Date:	18 November 2020 @ 2pm		
Venue:	(*Address Withheld*)		
Participant:	(*Name Withheld*)		
Participant Code:	5	**Profession**:	Software Trainer / Facilitator

The researcher must read the following terms to the participant and may only proceed once the participant has approved the process:

1. The participant has signed the relevant Informed Consent Form.
2. The participant has given the researcher permission to record the interview by means of transcription, photography, videography and/or audio recordings.
3. The participant has given the researcher permission to use the information gathered in a research study.
4. The participant knows that they can withdraw from the study at any point or refuse to answer any questions without consequences of any kind.

Signature of Participant Signature of Researcher

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Participant Responses During Individual Research Engagements.

Question:	Participant Response:
1. Do you think mobile and digital learning solutions can hold value in the current South African educational context?	
Participant-1: (Secondary School Teacher)	• Yes, mobile and digital learning has been a key factor, which has allowed for the continuation of teaching and learning during the COVID-19 lockdown. • However, this has only been possible due to the school's high economic status and the support by government for unprivileged learners. This support includes bursary programs with free internet access to qualifying learners.
Participant-2: (Secondary School Teacher)	• Yes, there is definitely a need for mobile and digital learning technologies in South Africa, due to the environmental and economic factors at hand. • Digital technologies can also reduce the cost of printing, for instance, which can be a large budgetary consideration for a school. • It has also been noticed that learners are more responsible with digital learning devices, as compared to textbooks, which are often damaged beyond use or missing. This might be due to the monetary and perceived value of the digital learning devices.
Participant-3: (Software Systems Analysis)	• Yes, mobile and digital learning has great value in South Africa in all levels of education, as it has the potential to reach a large number of learners due to the country's high mobile use. • Internet access should however be seen as a human right and the government should, like Scandinavian countries, make access to the internet available to all for free.
Participant-4: (Software (Developer)	• Yes, mobile and digital learning is egalitarian in that it provides a platform which can give equal and high-quality content to many people.

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	• These technologies also allow for the ability to access, through digital means, higher level educators who previously would have been inaccessible. This means that South Africa does not need to be bound geographically to locally available talents.
Participant-5: (Software Systems Trainer)	• Yes, mobile and digital learning offers the ability and solutions to bridge the infrastructure gap in South Africa. • Such technology can allow for a secure and stable platform that can be used to enhance the administrative system of education. However, the solutions need to be robust, and the data points need to be in place and accessible to all.
2. Based on your experience and expertise, what opportunities and possibilities are available to improve the implementation of mobile and digital learning technologies in schools?	
Participant-1: (Secondary School Teacher)	• There exists an opportunity to improve digital teaching tools that are able to accommodate the specific subject requirements. Subjects like mathematics and science, which requires formulae and drawings, have been challenging to teach over existing online platforms, such as Microsoft Teams and Zoom.
Participant-2: (Secondary School Teacher)	• It has become evident that learners are quite tech-savvy, and this general skill should be utilized, as it has been found that the technical training for learners to use new technologies are minimal. • Learners have commented that it is physically less taxing to carry around a single digital mobile device, as compared to a stack of textbooks, especially for learners who travel far distances by means of public transport. • The possibility of instant communication has been a great benefit, as learners can receive notes and information timeously, which negates delays in self-study.

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	• The virtual textbook solution implemented at the school (for grades 8-12's) is done by a local services provider, who also provides the necessary on-site technical support.
Participant-3: (Software Systems Analysis)	• From a software point is view, digital technologies can provide decentralized platforms, where information can be updated and shared instantly to users through a connected network • But there still exists great value in 'older' technologies, like online forums or discussion boards, which can offer a central platform and repository for engagements where learners can benefit from the information shared with others.
Participant-4: (Software (Developer)	• There exists a need for a unified and consolidated national system or repository, which is cloud-based, accessible and integrated into the entire South African educational system. • It is, however, important to consider an effective implementation based on the 'economy of scale' to ensure that the solutions are not 'watered-down' but scaled according to individual needs. • A country-wide implementation also provides the opportunity for government to employ experts in the field of education and software development - instead of duplicating the efforts in each province. This approach can potentially save costs and result in a superior system, which all provinces can benefit from.
Participant-5: (Software Systems Trainer)	• A digitally connected platform, which has been integrated nationally, also provides an opportunity for the development of a 'master set' of training and teaching courses and media for all teachers (nationally) to present their classes. There are however, no or few standardised courses and media that are accredited to be used in this way in South Africa. • There exists a need to maintain a balance between assisting or enhancing the work of a teacher through the implementation of digital technologies; and replacing the work of a teacher.

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3. Based on your experience and expertise, what barriers or challenges are against the implementation of mobile and digital learning technologies in South African schools?	
Participant-1: (Secondary School Teacher)	• Although digital technologies allow for instant communication, it can create a barrier between the learners and the teacher in terms of face-to-face communication and dynamic feedback. • The virtual classroom environment also lacks the social aspects of a regular classroom, where learners can engage collectively. For example, many learners can potentially benefit from the answer to one learner's question. • The use of off-the-shelf technologies, as well as how they are implemented and used, can often be limiting in terms of the workflow. For example, Apple iPad's, can only 'screenshare' with one device over Microsoft Teams. This limitation in the technology makes it impossible to share content digitally on the in-class monitor and online streaming service simultaneously. • It is also true that software and applications perform differently on different models or makes of devices, which can cause unnecessary teaching and learning challenges. • It has been found there are large numbers of learners who are unable to study on their own by means of mobile or digital teaching, due to their own levels of maturity and self-discipline or due to unsupportive home environments.
Participant-2: (Secondary School Teacher)	• The technical support and maintenance of both hardware and software is a critical component to consider during the implementation digital learning technologies. The support and maintenance component, which is often overlooked can be costly, especially if these services are outsourced instead of allocated to dedicated internal personnel.

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	• There has been a reluctancy by older teachers to adopt new digital technologies, which can hurdle the progression of school digitisation. • The jailbreaking of devices by learners in order to bypass the security and accessibility measures in place, is also a challenge. By jailbreaking the devices, learners then have the ability to upload non-educational apps like game, which can distract them from the educational content.
Participant-3: (Software Systems Analysis)	• The challenges South Africa, faces are not necessarily due to the lack of availability in technology, but rather the understanding of how to implement and integrate available tools effectively to create optimal solutions. • The pace at which technology changes can also prove to be a challenge, as attempts to develop technologies from concept to market often requires turn-around times that are not feasible, and the technology can potentially become redundant by the time that the solutions are ready for implementation. • It is vital the use of language of the platform does not create a barrier that prevents the access of information. Learners should be able to engage with the technology in their home language, not only to improve their comprehension of the knowledge, but also make it accessible to their supporting environment e.g., a parent who only speaks isiXhosa will be unable to assist their child on an English-only learning platform.
Participant-4: (Software (Developer)	• Corrupt government processes and failed services delivery remain a major hurdle in the advancement of mobile and digital technologies in school. • The availability of connectivity and cost of data also adds to the challenges learners face, especially in rural areas. One might look to a Low Orbit satellite solution to address this issue.

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	• Free universal, country-wide access to the internet is possible, as seen by Singapore's achievement of the same more than 15-years ago - although a much smaller and concentrated area. • Unfortunately, theft and criminal activities are, and will forever be, a major issue in South Africa.
Participant-5: (Software Systems Trainer)	• One would need to establish a baseline or median of technology practices, hardware and software die gauge the potential of universal mediums and media to rollout across South African effectively. • Collaboration between media and content creators to guide the development of suitable media should be emphasised. • It will be important to maintain a human connection in the media, so that the learning can be facilitated, and one does not attempt to shoehorn a classroom environment onto a laptop. • One should also consider the differences between the broadcast of information versus the narrowcast of information. • Even though the language localizations are important, there can be challenging as non-English words can be too long (number of characters) for the use on digital devices, or not exist.
4. Based on your experience and expertise, what are the key factors to consider when developing a framework for designing mobile and digital learning technologies for South African schools?	
Participant-1: (Secondary School Teacher)	• Teacher onboarding has been a major issue since the sudden shift towards digital learning due to the COVID-19 lockdown, as teachers had to immediately adopt new methods of teaching with minimal training and support. • It is also key to finding the most optimal medium for different programs and applications to work together. It is an often occurrence that the available medium does not meet the different subject requirements.

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	• It is also important to consider the quality of the technology, as some virtual platforms have poor video quality, and can be unsuitable for learning on a device with a small screen. • Most technologies are unable to provide an effective solution for online assessments and invigilation. For example, an automated assessment tool is unable to mark the learners process in solving a mathematics problem. • It is critical for educators to be part of the development process of mobile and digital learning technologies, as it will become their teaching tools. • Hardware and software lifespans have drastically decreased with the increase of use. It has been found that the school's maintenance and technical support costs have sharply increased since the switch to digital and mobile learning - even though the printing costs might have decreased.
Participant-2: (Secondary School Teacher)	• It is important that training is provided for both learners and teachers to use the devices and software. • The regular maintenance and repairs of devices are also important, in the attempt to reduce system down time. • It is also critical to have supporting infrastructure in place for the digital devises, such as charging station, secure storage, internet etc. • One also needs to develop a strategy to gain by-in from parents to purchase the devices if there are no sponsorships available.
Participant-3: (Software Systems Analysis)	• The most important factor to take into consideration is a support and maintenance strategy for the digital learning solution. It has been found that projects often fail due to the fact that there are no supporting and maintenance measures implemented alongside the solution to ensure its sustainability and improve its longevity. From a system usage perspective, the good solution does not need to be perfect, but reliable and consistent.

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Participant-4: (Software (Developer)	• The aim should be to develop a coherent and integrated plan - not a piece meal and disjointed approach. • It will be preferable to have a consolidated national plan with access to software and guidelines on what hardware to purchase for the establishment of an effective system. • It is also important for to have an on-site technical support personnel who can resolve issues timeously.
Participant-5: (Software Systems Trainer)	• One should also consider the regional localization of content, so that it reflects and is situated in the learner's environment. For example, consider a maths problem with cattle as items to calculate for a rural school - instead of a maths problem with planes to calculate, as these learners might not have ever seen such a thing. • It is also critical that the best possible people are appointed to help develop such a system, instead of an unqualified services provider that slips through the government's corrupt procurement process. • Most importantly, there should be strong institutional leadership throughout the process, to see development of such a system through from the conceptual- to the implementational phase.
5. From your perspective, do you have any suggestions to improve the current mobile and digital learning technologies used in South African schools?	
Participant-1: (Secondary School Teacher)	• Providing technical and software support to teachers, to assist with the onboarding process, will greatly improve the implementation of mobile and learning technologies in South African schools. • One needs to consider the monitoring of screen time, as learners now spend longer periods of time engaging with and through digital screes. This can potentially have an effect on their social of mental development. • It is also important to re-establish school times, as the concept of 'anytime learning' blurs the lines between work time and private time for teachers. As convenient as it is, to always be connected, one cannot expect teachers to be on constant standby. A potential

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	solution for this might be to separate school- and personal devices, but this is not always economically feasible.
Participant-2: (Secondary School Teacher)	• There exists a need for the current textbook-based infrastructure and processes to be upgraded to meet the demands of the digital environment. • A strategic overhaul of the education system is needed, so that the digital learning environment can be effectively implemented. • There needs to be a reduction in the cost of purchasing the rights to textbooks for digitization; and allow user to have lifetime access after purchase. • There will also be a great improvement in the implementation of mobile and digital technologies, if a central environment or platform is created that can integrate with the school's intranet, the internet (locked to have access to educational websites only), as well as other communication services, such as WhatsApp. • Funding needs to be made available for mobile and digital hardware, software and data - for both teachers and learners.
Participant-3: (Software Systems Analysis)	• The education system overall seems to be outdated in terms of facilitated classroom teaching, which often does not accommodate the differences in learning - especially with the various economic and social issues facing South Africa. • All the puzzle pieces are there; educational content, cell phone technology, access to internet, access to data etc., but there must be a political will to put these elements together strategically so that they form a coherent working system.
Participant-4: (Software (Developer)	• Centralization is key. There is a need for a centralized software depository, a centralized process of hardware purchasing, as well as a dedicated governmental agency or taskforce that works towards a strategic national implementation. • There is also a need for a standardised set of guidelines that can inform schools which digital strategy will be most suitable for their

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	individual implementation based on their resources and infrastructure.
Participant-5: (Software Systems Trainer)	• There seems to be a lack of trust in the current educational system and processes from all perspectives including learners, teachers, and the public due to the non-delivery of services. This would need to be addressed by the government in a critical way, so that trust in the system and processes can be regained. • There needs to be dedicated support services and infrastructure, which can support the system and processes after implementation. This ca be in the form of a responsive and effective help desk or call centre. • It is important to implement a strategic roll-out of mobile and digital learning initiatives in schools. One would, for example, first need to develop the infrastructure of impoverished schools to bring them to a point where the implementation of mobile and digital learning initiatives is feasible. For instance, it would be unwise to give a school with no electricity or data connection pc-tablets for digital learning, as there is no supporting infrastructure to maintain the implementation sustainably. All this said, poverty is a driver for unnatural actions.

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Addendum 9:

Request to Submit Research Probes

Reino Erasmus

Thesis presented in partial fulfilment
of the degree of Masters in Visual Arts
at the Visual Arts Department,
Faculty of Arts and Social Sciences
at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

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REQUEST TO SUBMIT RESEARCH PROBE

Dear Participant-1 (*Name Withheld*)

Thank you for the interview conducted on 13 November 2020 at 10am, at your residence in (*Address withheld*). I believe your insights on the topic of mobile learning in South Africa from an Educator's point of view will greatly assist in the development of the framework proposed in this study.

As mentioned, the text phase of our engagement will take the form of one 2-hour workshop, which will be scheduled at the convenience of all participants within the next two months.

In preparation for this, I kindly ask that submit 3 items to be used as research probes relevant to mobile learning in South Africa from your perspective on Monday, 7 December 2020. These items can be news articles, photographs, video clips, audio recordings / voice notes, written observations, illustrations etc., which will be used as discussion points during the next workshop.

Kind Regards,

Reino Erasmus

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REQUEST TO SUBMIT RESEARCH PROBE

Dear Participant-2 (*Name Withheld*)

Thank you for the interview conducted on 24 November 2020 at 9am, at your residence in (*Address withheld*). I believe your insights on the topic of mobile learning in South Africa from an Educator's point of view will greatly assist in the development of the framework proposed in this study.

As mentioned, the text phase of our engagement will take the form of one 2-hour workshop, which will be scheduled at the convenience of all participants within the next two months.

In preparation for this, I kindly ask that submit 3 items to be used as research probes relevant to mobile learning in South Africa from your perspective on Monday, 7 December 2020. These items can be news articles, photographs, video clips, audio recordings / voice notes, written observations, illustrations etc., which will be used as discussion points during the next workshop.

Kind Regards,

Reino Erasmus

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REQUEST TO SUBMIT RESEARCH PROBE

Dear Participant-3 (*Name Withheld*)

Thank you for the interview conducted on 13 November 2020 at 2pm, at your residence in (*Address withheld*). I believe your insights on the topic of mobile learning in South Africa from an Educator's point of view will greatly assist in the development of the framework proposed in this study.

As mentioned, the text phase of our engagement will take the form of one 2-hour workshop, which will be scheduled at the convenience of all participants within the next two months.

In preparation for this, I kindly ask that submit 3 items to be used as research probes relevant to mobile learning in South Africa from your perspective on Monday, 7 December 2020. These items can be news articles, photographs, video clips, audio recordings / voice notes, written observations, illustrations etc., which will be used as discussion points during the next workshop.

Kind Regards,

Reino Erasmus

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REQUEST TO SUBMIT RESEARCH PROBE

Dear Participant-4 (*Name Withheld*)

Thank you for the interview conducted on 18 November 2020 at 11am, at your residence in (*Address withheld*). I believe your insights on the topic of mobile learning in South Africa from an Educator's point of view will greatly assist in the development of the framework proposed in this study.

As mentioned, the text phase of our engagement will take the form of one 2-hour workshop, which will be scheduled at the convenience of all participants within the next two months.

In preparation for this, I kindly ask that submit 3 items to be used as research probes relevant to mobile learning in South Africa from your perspective on Monday, 7 December 2020. These items can be news articles, photographs, video clips, audio recordings / voice notes, written observations, illustrations etc., which will be used as discussion points during the next workshop.

Kind Regards,

Reino Erasmus

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REQUEST TO SUBMIT RESEARCH PROBE

Dear Participant-5 (*Name Withheld*)

Thank you for the interview conducted on 18 November 2020 at 2pm, at your residence in (*Address withheld*). I believe your insights on the topic of mobile learning in South Africa from an Educator's point of view will greatly assist in the development of the framework proposed in this study.

As mentioned, the text phase of our engagement will take the form of one 2-hour workshop, which will be scheduled at the convenience of all participants within the next two months.

In preparation for this, I kindly ask that submit 3 items to be used as research probes relevant to mobile learning in South Africa from your perspective on Monday, 7 December 2020. These items can be news articles, photographs, video clips, audio recordings / voice notes, written observations, illustrations etc., which will be used as discussion points during the next workshop.

Kind Regards,

Reino Erasmus

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Addendum 10:
Invitations to Participate in Participatory Design Engagement

Reino Erasmus

Thesis presented in partial fulfilment
of the degree of Masters in Visual Arts
at the Visual Arts Department,
Faculty of Arts and Social Sciences
at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

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INVITATION TO PARTICIPATE IN RESEARCH STUDY - PARTICIPATORY DESIGN ENGAGEMENT

Dear Participant-1 (*Name Withheld*)

Thank you again for insights provided during our first research interview on 13 November 2020 at 10am.

As mentioned, our next engagement will be a 2-hour participatory design workshop, which will consist of 8 activities, with a time allocation of 15-minutes per activity.

The engagement is schedule below:

Venue:	(*Address Withheld*)
Date:	**Saturday, 10 April, 2021**
Time:	**10am**

Refreshments will be provided.

Please confirm your attendance before Friday, 9 April, 2021.

Kind Regards,

Reino Erasmus

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INVITATION TO PARTICIPATE IN RESEARCH STUDY - PARTICIPATORY DESIGN ENGAGEMENT

Dear Participant-2 (*Name Withheld*)

Thank you again for insights provided during our first research interview on 24 November 2020 at 9am.

As mentioned, our next engagement will be a 2-hour participatory design workshop, which will consist of 8 activities, with a time allocation of 15-minutes per activity.

The engagement is schedule below:

Venue:	(*Address Withheld*)
Date:	**Saturday, 10 April, 2021**
Time:	**10am**

Refreshments will be provided.

Please confirm your attendance before Friday, 9 April, 2021.

Kind Regards,

Reino Erasmus

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INVITATION TO PARTICIPATE IN RESEARCH STUDY - PARTICIPATORY DESIGN ENGAGEMENT

Dear Participant-3 (*Name Withheld*)

Thank you again for insights provided during our first research interview on 13 November 2020 at 2pm.

As mentioned, our next engagement will be a 2-hour participatory design workshop, which will consist of 8 activities, with a time allocation of 15-minutes per activity.

The engagement is schedule below:

Venue:	(*Address Withheld*)
Date:	**Saturday, 10 April, 2021**
Time:	**10am**

Refreshments will be provided.

Please confirm your attendance before Friday, 9 April, 2021.

Kind Regards,

Reino Erasmus

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INVITATION TO PARTICIPATE IN RESEARCH STUDY - PARTICIPATORY DESIGN ENGAGEMENT

Dear Participant-4 (*Name Withheld*)

Thank you again for insights provided during our first research interview on 18 November 2020 at 11am.

As mentioned, our next engagement will be a 2-hour participatory design workshop, which will consist of 8 activities, with a time allocation of 15-minutes per activity.

The engagement is schedule below:

Venue:	(*Address Withheld*)
Date:	**Saturday, 10 April, 2021**
Time:	**10am**

Refreshments will be provided.

Please confirm your attendance before Friday, 9 April, 2021.

Kind Regards,

Reino Erasmus

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INVITATION TO PARTICIPATE IN RESEARCH STUDY - PARTICIPATORY DESIGN ENGAGEMENT

Dear Participant-5 (*Name Withheld*)

Thank you again for insights provided during our first research interview on 18 November 2020 at 2pm.

As mentioned, our next engagement will be a 2-hour participatory design workshop, which will consist of 8 activities, with a time allocation of 15-minutes per activity.

The engagement is schedule below:

Venue:	(*Address Withheld*)
Date:	**Saturday, 10 April, 2021**
Time:	**10am**

Refreshments will be provided.

Please confirm your attendance before Friday, 9 April, 2021.

Kind Regards,

Reino Erasmus

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Addendum 11:
Written Consent for Participatory Design Research Engagements

Reino Erasmus

Thesis presented in partial fulfilment
of the degree of Masters in Visual Arts
at the Visual Arts Department,
Faculty of Arts and Social Sciences
at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

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CONSENT TO PARTICIPATE IN RESEARCH

PARTICIPATORY DESIGN ENGAGEMENT

Dear Participant-1 (*Name Withheld*)

Preliminary research into the field of mobile learning applications in Nelson Mandela Bay has identified you as a key stakeholder for consultation. You have therefore been asked to participate in a research study into this field.

The research will be conducted by Mr. Reino Erasmus, who is currently a master's student at the Department of Visual Arts at the Stellenbosch University. His research paper aims to gain a deeper understanding in the development of mobile learning experiences within the South African content.

Participants of this study will be asked to do the following;

1. Participate in a 2-hour workshop where they will be asked to respond to questions, or engage in activities related to mobile learning experiences.
2. Allow the researcher to document the interviews and/or facilitated workshops by means of transcription, photography, video recording and/or audio recordings.
3. Allow the researcher to use the information gathered in a research study.

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Please note the following Terms and Conditions:

a) In light of the active coronavirus pandemic, no participants will be asked to engage in-person with the researcher or other participants until such time that the South African government lifts the restrictions currently in place. However, it is important to note that participants will always have the option to participate virtually through digital communication technologies, such as Skype, Zoom, WhatsApp Video Call, FaceTime etc.
b) Participants will not directly benefit from this study or receive any payment. The research paper is aimed at the benefit of society by attempting to alleviate some the challenges the education sector is facing with the implementation of "digital" and "paperless" classrooms.
c) The confidentiality and privacy of all participants will be strictly maintained as required by law. The research paper will not publish any personal information; nor will the researcher disclose any personal information gained through this study.
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f) Should any concerns arise, you may contact the researcher Mr. Reino Erasmus [erasmus.re@gmail.com, 067 687 6448] or the research supervisor: Dr. Karolien Perold [karolien@sun.ac.za, 021 808 3046] directly.
g) Participants are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms. Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

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DECLARATION OF CONSENT BY PARTICIPANT

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I hereby consent voluntarily to participate in this study.

(*Name Withheld*)
Name of Participant

Signature of Participant

10 April 2020
Date

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CONSENT TO PARTICIPATE IN RESEARCH

PARTICIPATORY DESIGN ENGAGEMENT

Dear Participant-2 (*Name Withheld*)

Preliminary research into the field of mobile learning applications in Nelson Mandela Bay has identified you as a key stakeholder for consultation. You have therefore been asked to participate in a research study into this field.

The research will be conducted by Mr. Reino Erasmus, who is currently a master's student at the Department of Visual Arts at the Stellenbosch University. His research paper aims to gain a deeper understanding in the development of mobile learning experiences within the South African content.

Participants of this study will be asked to do the following;

1. Participate in a 2-hour workshop where they will be asked to respond to questions, or engage in activities related to mobile learning experiences.
2. Allow the researcher to document the interviews and/or facilitated workshops by means of transcription, photography, video recording and/or audio recordings.
3. Allow the researcher to use the information gathered in a research study.

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(Name Withheld)
Name of Participant

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CONSENT TO PARTICIPATE IN RESEARCH

PARTICIPATORY DESIGN ENGAGEMENT

Dear Participant-3 (*Name Withheld*)

Preliminary research into the field of mobile learning applications in Nelson Mandela Bay has identified you as a key stakeholder for consultation. You have therefore been asked to participate in a research study into this field.

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(Name Withheld)

Name of Participant

Signature of Participant

10 April 2020

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CONSENT TO PARTICIPATE IN RESEARCH

PARTICIPATORY DESIGN ENGAGEMENT

Dear Participant-4 (*Name Withheld*)

Preliminary research into the field of mobile learning applications in Nelson Mandela Bay has identified you as a key stakeholder for consultation. You have therefore been asked to participate in a research study into this field.

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(Name Withheld)

Name of Participant

Signature of Participant

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CONSENT TO PARTICIPATE IN RESEARCH

PARTICIPATORY DESIGN ENGAGEMENT

Dear Participant-5 (*Name Withheld*)

Preliminary research into the field of mobile learning applications in Nelson Mandela Bay has identified you as a key stakeholder for consultation. You have therefore been asked to participate in a research study into this field.

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Addendum 12:

Research Probes Submitted by Research Participants

Reino Erasmus

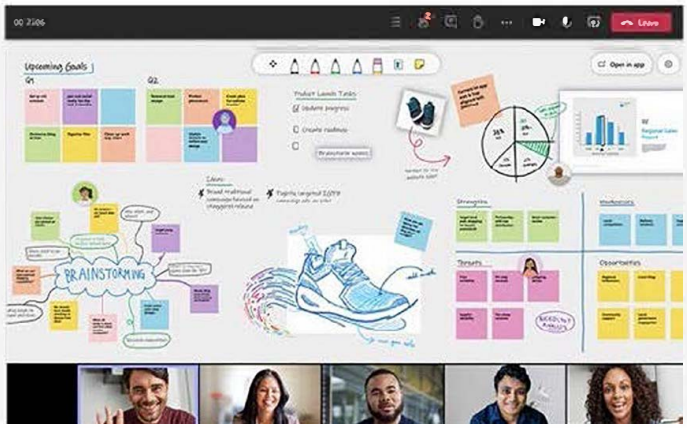
Thesis presented in partial fulfilment
of the degree of Masters in Visual Arts
at the Visual Arts Department,
Faculty of Arts and Social Sciences
at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

Stellenbosch University https://scholar.sun.ac.za

Research Probes Submitted by Research Participants.

Participant:	Research Probes:
Participant-1:	 https://www.trueeducationpartnerships.com/schools/tips-for-engaging-lessons-with-microsoft-teams/
	 https://www.techlearning.com/how-to/microsoft-teams-tips-and-tricks-for-teachers
	 https://www.youtube.com/watch?v=RwMP33N0Usw

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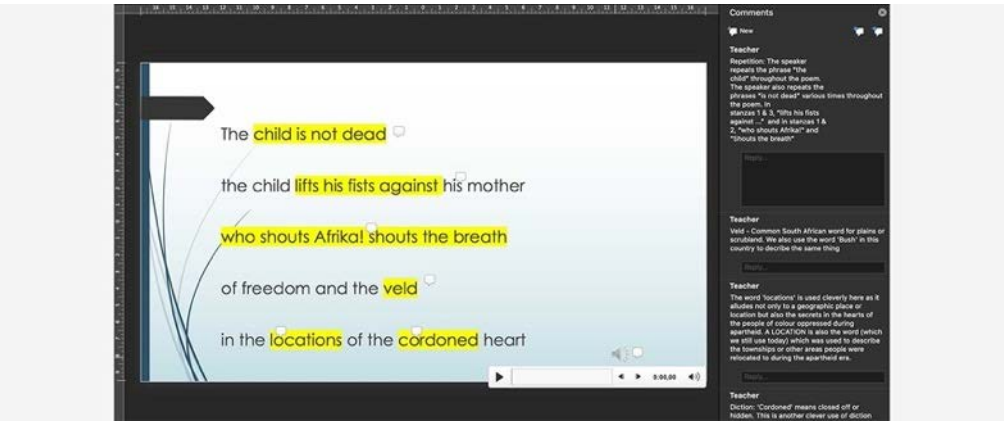
Participant-2:	 https://apps.apple.com/za/app/miebooks/id881060638
	 https://itsieducation.com/
	 (Received digitally from participant)

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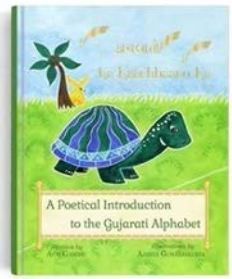
Participant-3	 What is mother tongue in education? Mother tongue in education refers to when a school or educational institution integrates the language a child is most familiar with (their mother tongue) into the classroom lesson along with the school's lesson (such as English). This is normally the language that the child speaks at home with their family. https://ie-today.co.uk/comment/the-importance-of-mother-tongue-ineducation/
	 5 reasons why it is important to know your mother tongue really well https://www.linkedin.com/pulse/5-reasons-why-important-know-your-mother-tongue-really-sandeep-nulkar/
	 A Poetical Introduction to the Gujarati Alphabet The book is tailored towards an audience that does not know Gujarati at all. There is text in Gujarati within the book, but it is all transliterated. There is also a short lesson at the end on basic conversation. I hope that resources like these will help people learn their mother tongue and spread the knowledge on to the next generation. https://kitaabworld.com/blogs/in-focus/five-reasons-why-you-must-teach-your-child-your-mother-tongue-and-how-you-can-do-it

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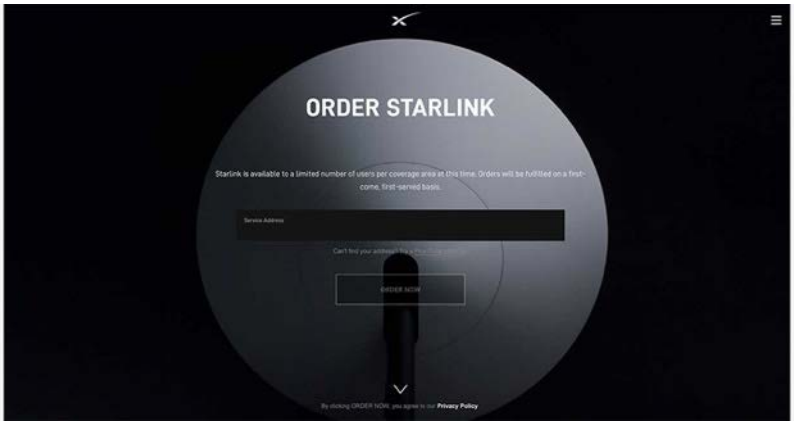
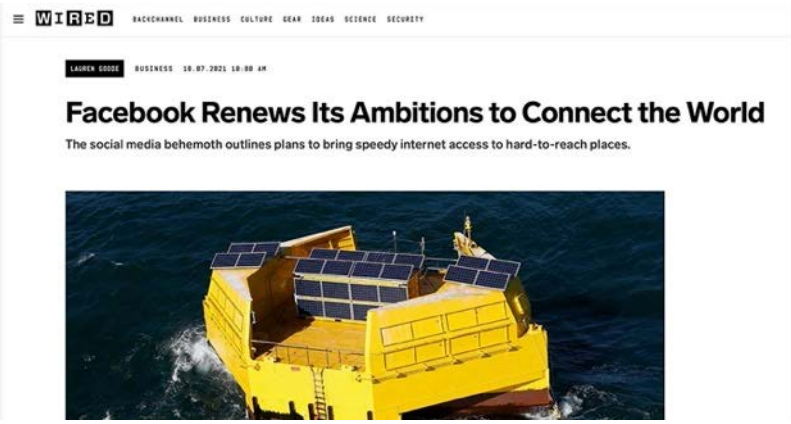
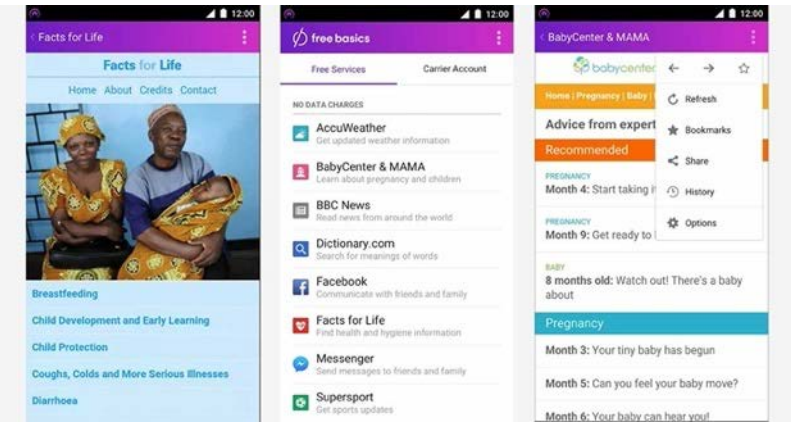
Participant-4	 https://www.starlink.com
	 https://www.wired.com/story/what-happened-to-facebooks-grand-plan-to-wire-the-world/
	 https://free-basics-by-facebook.en.uptodown.com/android

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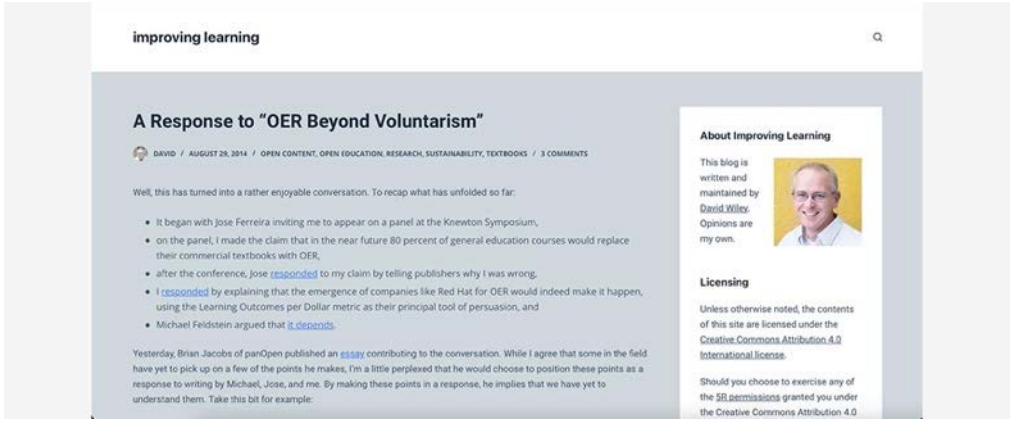
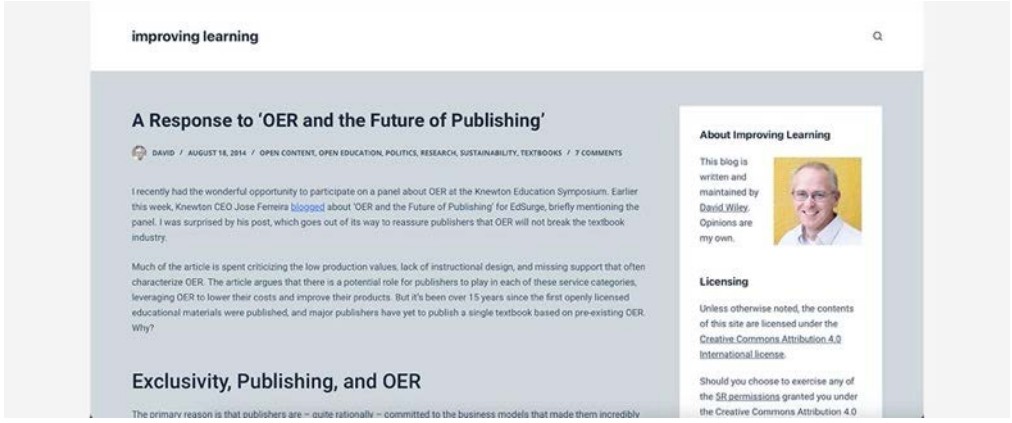
Participant-5	 https://www.edsurge.com/news/2014-09-03-opinion-why-can-t-oer-enjoy-the-same-success-as-open-source-software
	 https://opencontent.org/blog/archives/3496
	 https://opencontent.org/blog/archives/3462

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Addendum 13:

Completed Participatory Design Diagram

Reino Erasmus

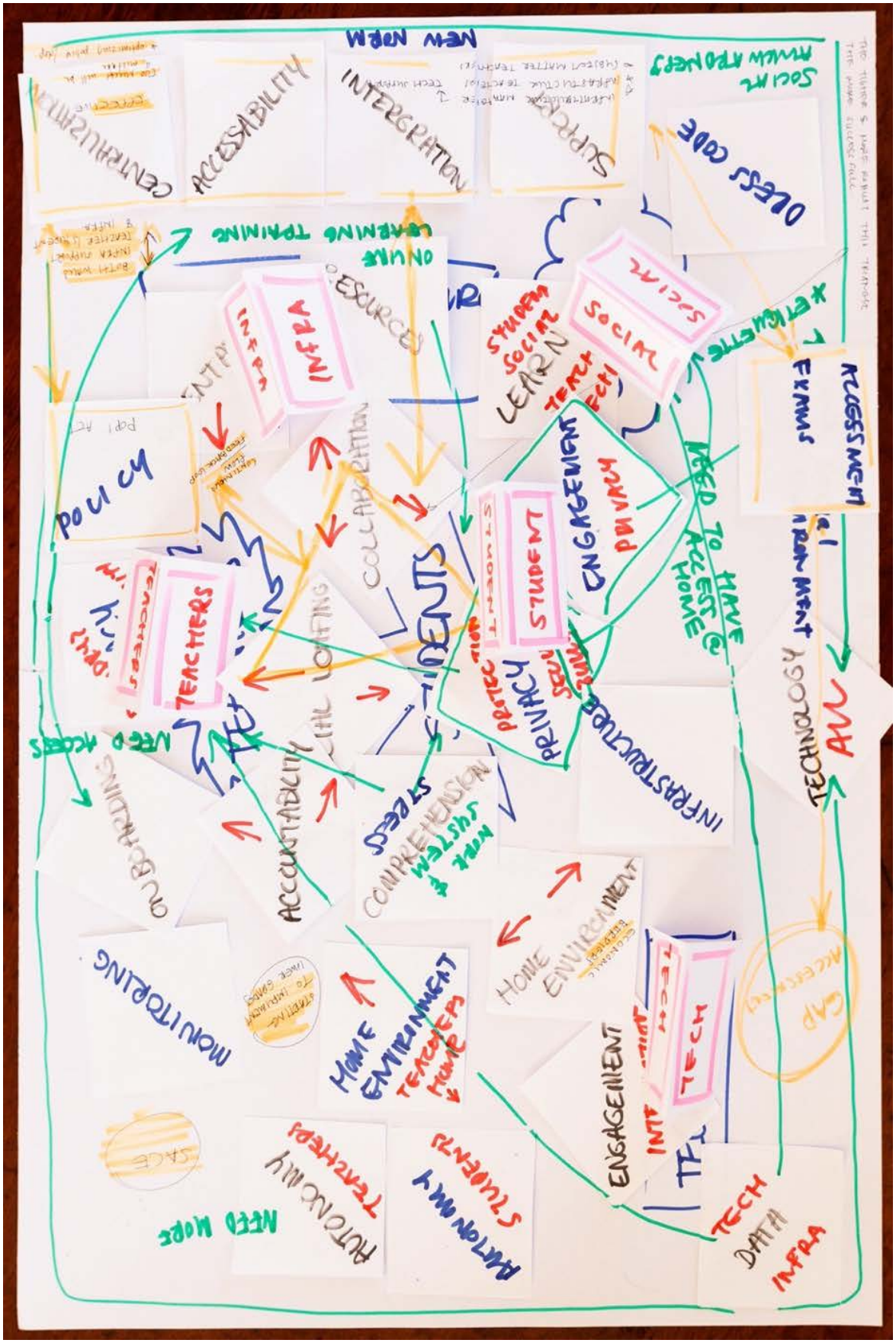
Thesis presented in partial fulfilment
of the degree of Masters in Visual Arts
at the Visual Arts Department,
Faculty of Arts and Social Sciences
at Stellenbosch University.

Supervisor: Dr. Karolien Perold-Bull

April 2022

Stellenbosch University https://scholar.sun.ac.za

Completed Participatory Design Diagram.



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Addendum 14:

Framework Presented as Flow Diagram

Reino Erasmus

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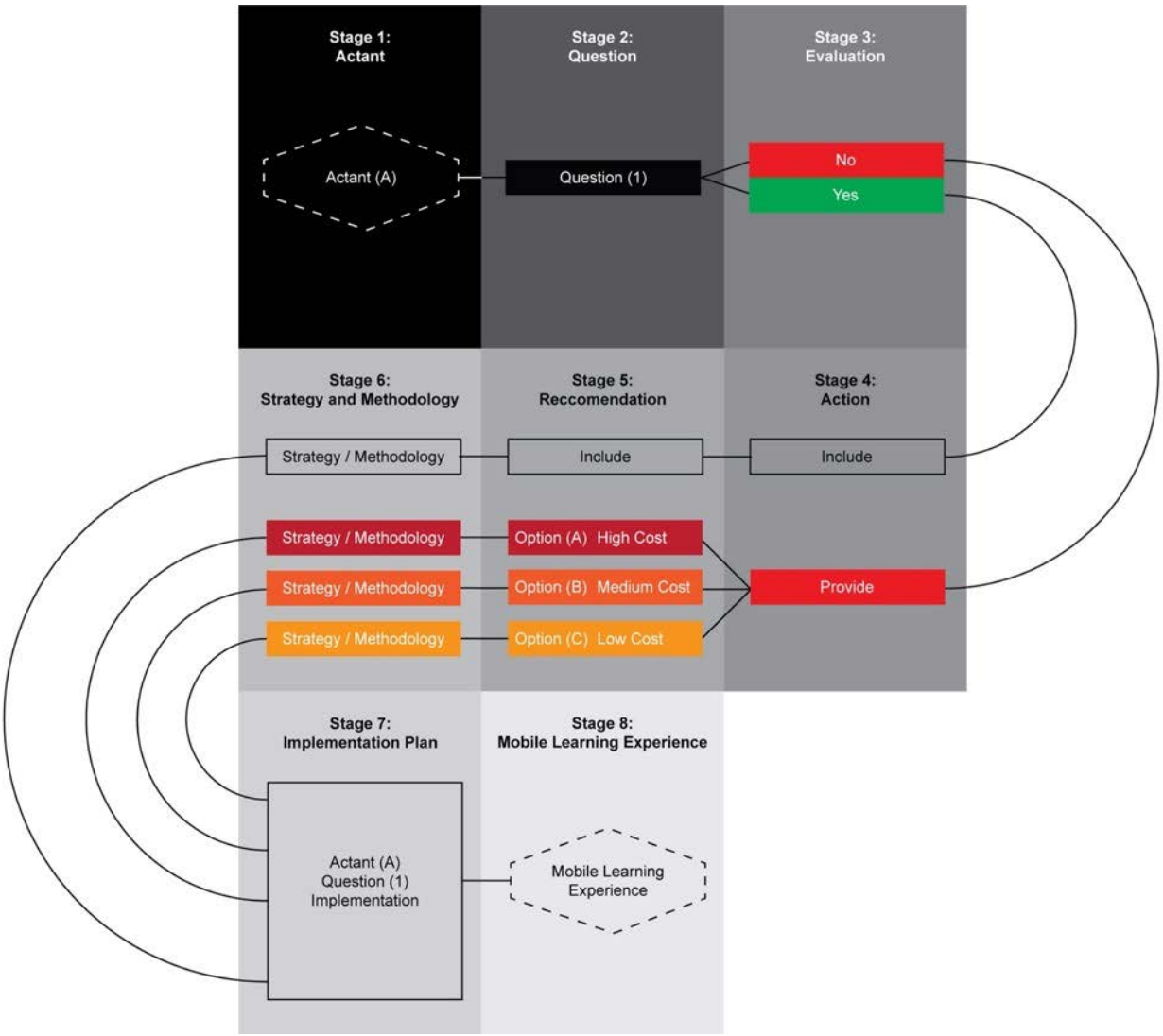
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