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Determinants of mobile learning acceptance among grade 12 learners, their parents and teachers in the rural King Cetshwayo District

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DECLARATION

I hereby declare that this thesis is my own unaided work and that any assistance obtained has been fully acknowledged in the text. No part of this thesis has been previously submitted to any other University.

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David Mutambara

ABSTRACT

Science, Technology, Engineering, and Mathematics (STEM) is faced with challenges, resulting in learners' poor performance at the matriculation level, in South Africa. In trying to improve learners' performance in STEM-related subjects in grade 12, the Department of Basic Education, and other stakeholders, encouraged the use of mobile learning in the classroom. However, the adoption of mobile learning is contingent on the user's attitude towards it. Despite the call by the Department of Basic Education to use mobile learning, very little is known about rural school STEM learners', their teachers', and parents' acceptance of mobile learning.

In response to the lack of such limited and established studies in rural settings, this study proposed and used the South African Schools' Technology Acceptance Model (SASTAM) to investigate the factors that influence rural high school STEM learners', their parents' and teachers' behavioural intention to use mobile learning for STEM learning. The SASTAM is based on the Technology Acceptance Model specifically, to examine significant differences between rural high school STEM learners' and their parents' and teachers' acceptance of mobile learning. Identifying and understanding the factors that influence the acceptance of mobile learning is key to its successful implementation.

The study used an explanatory sequential mixed method design to investigate mobile learning technology acceptance in rural high schools in King Cetshwayo District. Stratified random sampling was used to select 550 rural high school STEM learners, their parents, and teachers to participate in the survey. The results from 417 respondents were stored as data and were analysed using partial least squares structural equation modeling (PLS-SEM). After quantitative data analysis were conducted,12 participants were selected to take part in interviews.

The SASTAM was validated using PLS-SEM. The results revealed that the variance explained by the model in the behavioural intention of learners, parents, and teachers was 44.3%, 39.7%, and 43.8% respectively. The data from the learners, teachers, and parents were combined and analysed and the variances in behavioural intention to use mobile learning, which was explained by the SASTAM, was 40.8%. Original Technology Acceptance Model variables (perceived attitude towards the use, perceived usefulness and perceived ease of use) had a direct influence on behavioural intention, and they also played mediating roles between the external variables (perceived social influence, perceived psychological readiness, perceived skills readiness and perceived resources) and behavioural intention to use mobile learning in a rural setting.

Multigroup analysis results showed that, for parents and learners, three paths (perceived ease of use to perceived attitude, perceived resources to perceived ease of use, and perceived social influence to perceived attitude towards the use) were significantly different. In contrast, only one path (perceived resources to perceived attitude towards the use) was significantly different for learners and teachers. However, all the paths were significant in each group, meaning that SASTAM can be used to predict the acceptance of mobile learning for rural high school STEM learners, their parents, and teachers.

The results of this study will both inform the Department of Basic Education of the factors that rural high STEM parents, learners and teachers consider important when accepting mobile learning, and advance the debate on the conceptual understanding of technology acceptance in education by refining the Technology Acceptance Model to suit the context, leading to a deeper understanding of factors that affect mobile learning acceptance in rural areas of developing countries.

Keywords: Acceptance, behavioural intention, M-learning, perceived attitude towards, STEM

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TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

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CHAPTER 1

1.1 Introduction

Science, Technology, Engineering and Mathematics (STEM) Task Force Report (2014, p. 9) in America, adopted the opinion that STEM education is "far more than a 'convenient integration' of its four disciplines, rather, it encompasses 'real-world, problem-based learning' that integrates the disciplines through cohesive and active teaching and English learning approaches". What can be learned from this view is that STEM education aims at teaching learners to solve real-world problems, collaborate, integrate these four disciplines, rather than learning them separately, just as they do not exist as separate disciplines in the real world.

As STEM education is in its infancy in South African high schools, it is faced with many challenges, such as lack of learning material, science laboratories, and parental involvement, resulting in learners' poor performance at the matriculation level (Eagly & Chaiken, 1993; Makgato, 2006; Mokgwathi, Graham, & Fraser, 2019). The subjects in which most South African high school learners struggle with are Mathematics and Physical Sciences (Department of Basic Education, 2018; Mokgwathi et al., 2019; Mupira & Ramnarain, 2018; Nkambule & Amsterdam, 2018). Evidence in South Africa suggests poor performance in Mathematics and Physical Sciences (Bosman & Schulze, 2018; Mji & Makgato, 2006; Siyepu, 2013; Pournara, Hodgen, Adler & Pillay, 2015). Coupled with local assessment, international assessments in mathematics and science, like the Trends in International Mathematics and Science Studies, show that, compared to other developing countries, South African learners' performance in Science and Mathematics is very poor, especially for black learners in rural areas (Mupira & Ramnarain, 2018). A report by the World Economic Forum (2015) on performance in Mathematics and Physical Sciences placed South Africa at position 138, out of 140 countries.

Science, Technology, Engineering, and M education is faced with many challenges in rural high schools (Bosman & Schulze, 2018; Bourgonjon, Valcke, Soetaert & Schellens, 2011; Burke et al., 2014; Department of Basic Education, 2017; Mashaba

& Maile, 2018). According to Bosman and Schulze (2018), teachers use traditional face-to-face instruction (FTF) which fails to stimulate deep holistic learning experiences. A high rate of teacher absenteeism and poor time management contributes to poor learners' performance (Mashaba & Maile, 2018). On average teachers in rural areas teach 3,5 hours a day, as compared to 6,5 hours in urban areas (ibid). The South African Department of Basic Education (DoE) noted that the language barrier was one of the causes of poor performance (Department of Basic Education, 2014, 2015, 2016, 2017). Based on these studies (Bosman & Schulze, 2018; Department of Basic Education, 2014, 2015, 2016, 2017; Mashaba & Maile, 2018), one can conclude that there is no effective STEM teaching and learning.

Lack of science laboratories and equipment to enhance effective STEM teaching and learning in rural high schools contribute to poor learners' performance (Makgato, 2007; Mboweni, 2014). Vesser, Juan, and Feza (2015) attributed this poor performance in STEM-related subjects in rural areas to the lack of learning materials and textbooks. The conclusion that can be drawn from these studies (Makgato, 2007; Mboweni, 2014; Visser et al., 2015) is that in rural areas, there is a lack of materials for effective STEM teaching and learning.

Based on the studies by Bosman and Schulze (2018), Chan and Norlizah (2017), Department of Basic Education (2014), Makgato (2007), and Modisaotsile (2012), it may be concluded that the STEM education in rural areas is faced with many challenges. Makgato (2007) found that lack of science laboratories and lack of motivation affects STEM education in rural areas. The STEM education in rural areas is also affected by teachers' teaching strategies, poor time management, and STEM education being perceived as boring and challenging (Bosman & Schulze, 2018; Department of Basic Education, 2014). Furthermore, lack of parent involvement contributes to poor learners' performance in STEM-related subjects (Modisaotsile, 2012; Nokwali et al., 2015).

To minimize the impact of these challenges in STEM education, the Department of Basic Education encouraged teachers to integrate mobile learning (M-learning) in their teaching (Department of Basic Education, 2017). A plethora of studies has shown that mobile learning can be used to mitigate the challenges of STEM education (Almaiah, Jalil & Man, 2016; Alrajawy, Norzaidi, Isaac & Mutahar, 2017; Koehler & Mishra, 2016; Pinker, 1997). Mobile learning is defined as learning which makes use of wireless devices like iPods, laptops, smartphones, USBs, cameras, and PDAs (Lu & Viehland, 2008). According to Koehler and Mishra (2016), mobile learning changes a teacher-centred approach to learner-centred, which can stimulate deep holistic learning experiences. Mobile learning also provides teachers with many different pedagogies such as educational games, quizzes, and group work which can be utilized to meet learners' diverse learning styles (Yeap et al., 2016). M-learning enables the use of visualized science experiments, which can improve learners' knowledge of science, and enable them to give complete explanations of scientific concepts (Pinker, 1997). The Department of Basic Education (2017) stated that learning materials that included notes, textbooks past examination papers and their marking guidelines, and mathematics and science intervention study materials were available on the Department of Basic Education's website (DoE, 2017). According to Kong (2018), mobile learning improves parents' involvement in their children's learning, which in turn improves learners' motivation and performance in STEM-related subjects. What can be learned from studies is that M-learning can lessen the challenges faced by STEM education in rural high schools (Al-Emran & Salloum, 2017; Alrajawy et al., 2017; Department of Basic Education, 2017; Kong, 2018; Yeap et al., 2016).

However, despite the positive effects that M-learning can bring to rural high school STEM learners and the ubiquity of mobile devices, its adoption into classrooms is far below the expected rate (Dutota, Bhatiasevib, & Bellallahom, 2019; Sánchez-Prietoa, Hernández-Garcíab, García-Peñalvoa, Chaparro-Peláezb, & Olmos-Migueláñeza, 2019). Additionally, researchers have suggested a deficit between what mobile learning offers and what it is used for (Dutota, Bhatiasevib & Bellallahom, 2019; Sánchez-Prietoa, Hernández-Garcíab, García-Peñalvoa, Chaparro-Peláezb & Olmos-Migueláñeza, 2019). Padmanathan and Jogulu (2018) stated that the successful adoption of mobile learning depends on the user's acceptance. As a consequence of assessment by Padmanathan and Jogulu (2018), it could be argued that the successful implementation of mobile learning in high schools of developing countries requires investigation into the users' attitudes.

The users of mobile learning at the high school level include learners, teachers, and parents. Little is known of the effects of the factors that affect mobile learning acceptance, such as perceived ease to collaborate; perceived usefulness; skills readiness; psychological readiness; perceived enjoyment; perceived ease of use, and perceived attitude towards using mobile learning of these three groups of users. This is because most studies on the acceptance of mobile learning have been carried out in developed countries' institutions of higher learning, and not in rural high schools of developing countries.

1.2 Scope of the Study

Successful implementation of mobile learning in high schools requires all stakeholders' perceptions to be considered. Some academics have stated that the implementation of mobile learning is a complex process that needs considering the perspective of teachers, learners and parents, as they are the stakeholders that are affected (Robertson, Grady, Fluck, & Webb, 2006; Zhu, Yang, MacLeod, Shi, & Wu, 2018). If one of the stakeholders is not considered when decisions are taken, the whole process may fail (Ford & Botha, 2010). The successful implementation of mobile learning is contingent on the willingness of users to utilize it (Wang, Wu, & Wang, 2009). Several studies were conducted to find the attitude of the three main stakeholders within a university setting that is lecturers, administrators and students towards mobile learning (Jaradat, 2010; Joo, Park, & Lim, 2018; Muhammet & Okan, 2018; Padmanathan & Jogulu, 2018; Usagawa & The, 2018). However, very little is known about the perceptions of the three stakeholders within rural high schools.

At the high school level, the three main stakeholders who need to be considered for the successful implementation of mobile learning are parents, teachers and learners (Baek, Zhang, & Yun, 2017; Leem & Sung, 2018; Odiakaosa, Dlodlo, & Jere, 2017; Zhu et al., 2018). Learners are the main stakeholders as they are the ones who use mobile learning for learning. Teachers are the ones who would help learners to learn through mobile learning by providing learning material, delivery of lessons, assessing learners, and guiding learners through the whole process of mobile learning. Parents need to be considered because they are the ones who are responsible for providing financial support for mobile learning, such as buying the devices and providing mobile data.

It is very crucial to understand the needs of all the stakeholders because if one of them is not committed, the implementation will be unsuccessful. For example, Ford and Botha (2010) noted that one of the reasons why the Gauteng Online project failed, even after the Gauteng Department of Education invested R3 billion, was the lack of consultation with teachers, parents, and learners. Therefore, investigating the factors that influence rural high school STEM learners', their parents', and teachers' acceptance of mobile learning is crucial for successful implementation. Ford and Botha (2010) stressed the need for South Africa to carry out its mobile learning acceptance studies and not to blindly follow examples from developed countries. In support of this argument, Al-Hamad, AlHamad and Al-Omari (2020) stated that each community has its specificity and unique standards. Based on the assessment by Ford and Botha (2010), the aim of the study is highlighted in the next section.

1.3 Purpose of the Study

Based on the contestations this far, the purpose of this study is to examine factors that influence STEM grade 12 learners, their teachers, and parents in rural areas of King Cetshwayo District to accept mobile learning. The study also seeks to ascertain if there are significant differences among the factors that rural high school grade 12 learners, their teachers, and parents consider important when mobile learning.

Based on the constructs of Technology Acceptance Model (Davis, 1989), a new extended TAM called South African Schools' Technology Acceptance Model (SASTAM) is proposed and to be applied. SASTAM is designed by adding variables (perceived resources, perceived ease to collaborate, perceived psychological readiness, perceived social influence, perceived enjoyment, and perceived skills readiness) to TAM to predict user acceptance of mobile learning.

1.4 Statement of the Problem

In trying to improve learners' performance in STEM-related subjects in grade 12, the Department of Basic Education (2014, 2015, 2017) has encouraged the use of mobile learning in classrooms. Mobile learning has the ability to change teacher-centred pedagogy to learner-centered, which enables learners to have more collaborative engagements that can enable the construction of knowledge through deep meaningful learning experiences (Bazelais & Doleck, 2018). Evidence from past studies has suggested that mobile learning improves learners' performance (Bazelais & Doleck, 2018; Hwang & Chang, 2011; Males, Bate, & Macnish, 2017). The Department of Basic Education and other stakeholders are encouraging teachers to adopt mobile learning in classrooms (Mutono & Dagada, 2016).

Davis (1989) stated that the successful adoption of any information system is contingent on its user's acceptance. In the mobile learning context, Iqbal and Bhatti (2015) noted that the acceptance of mobile learning greatly be contingent on its users' attitude towards it. As a consequence of the assessment of Iqbal and Bhatti (2015), it could be argued that the successful implementation of mobile learning in South African rural high schools requires investigation on teachers', learners', and parents' attitudes.

Despite the call by the Department of Basic Education for the adoption of mobile learning, very little is known about rural school STEM grade 12 learners', their teachers', and learners' acceptance of mobile learning. Consequently, there is a need to investigate the acceptance of mobile learning and to investigate the factors that influence STEM grade 12 learners, their parents, and teachers to accept mobile learning in the rural high school context. The specific research questions associated with the current study are given in the following section.

1.5 Research Questions

In attempting to investigate factors that influence rural high school STEM grade 12 learners, their parents and teachers to accept mobile learning and the inter-relationships between grade 12 learners', their teachers' and parents' attitudes towards mobile learning acceptance, the following research questions were asked:

1. What is the effect of rural high school STEM learners' perceived usefulness, perceived enjoyment, perceived ease of use, perceived attitude towards the use, perceived psychological readiness, perceived skills readiness, perceived resources, perceived ease to collaborate, and perceived social influence on their behavioural intention to use mobile learning?
2. What are the factors that rural high school STEM teachers consider important when accepting mobile learning?
3. What are the factors influencing parents of rural high school STEM grade 12 learners to allow their children to use mobile learning?
4. Are there significant differences among the factors that rural high school grade 12 learners, their teachers and parents consider important when accepting mobile learning?

1.6 Objectives

The following researcher objectives were formulated:

1. To investigate the effect of rural high school STEM learners' perceived usefulness, perceived enjoyment, perceived ease of use, perceived attitude towards the use, perceived psychological readiness, perceived skills readiness, perceived resources, perceived ease to collaborate, and perceived social influence on their behavioural intention to use M-learning.
2. To analyse factors that influence rural high school STEM teachers to consider important when accepting mobile learning.
3. To examine factors that affect parents of rural high school STEM grade 12 learners to allow their children to use mobile learning.
4. To find out if there are significant differences among the factors that rural high school grade 12 learners, their teachers, and parents consider important when accepting mobile learning.

1.7 Potential Contribution

This study contributes to the body of knowledge by investigating, the factors that rural high school STEM learners, their parents, and teachers consider important when accepting mobile learning, while its importance is realized by the methodological, theoretical, and practical significance outlined in the following subsections.

1.7.1 Theoretical Potential Contributions

Since Davis et al. (1989) recommended that the Technology Acceptance Model structure (belief-attitude-intention-behaviour), can be applied to different information systems (IS) and user population, it has been made use of in several different technology acceptance studies (Pituch & Lee, 2006). The Technology Acceptance Model was also well received and used to predict user acceptance in the mobile learning context (Dutota et al., 2019; Estriegana, Medina, & Roberto, 2019; Mohammadi & Mahmoodi, 2019; Sánchez-Prietoa et al., 2019). However, Oats, Kapeko, and Kelebeng (2019) found that studies that use the Technology Acceptance Model to explain the acceptance of mobile learning in developing countries were limited, especially in rural areas. The current research intends to provide additional information on the external factors of the Technology Acceptance Model that can be used to explain STEM users' acceptance of mobile learning in rural areas.

This study developed the South African Schools' Technology Acceptance Model by extending the Technology Acceptance Model. The SASTAM encompasses the factors (perceived ease of use, perceived skills readiness, perceived resources, perceived social influence, perceived psychological readiness, perceived ease to collaborate, perceived enjoyment, perceived usefulness, and perceived attitude towards) that can influence the behavioural intention of high school STEM learners, their teachers, and parents in a rural context to accept mobile learning. By evaluating the SASTAM, this study intended to provide external factors that may be added to the Technology Acceptance Model to predict the adoption of mobile learning by learners, teachers, and parents in a rural context. Additionally, the study intended to provide an understanding of the causal relationships among the added external factors and the Technology Acceptance Model.

1.7.2 Practical Potential Contribution

Understanding the determinants of rural high school STEM grade 12 learners', their teachers' and parents' acceptance and use of M-learning before investing in it is essential to the successful implementation of mobile learning in South Africa. Before investing in the development of mobile learning platforms and contents, the Department of Education and other stakeholders should be able to anticipate factors that influence rural grade 12 learners', their teachers', and parents' acceptance of mobile learning. This information can enable the Department of Education to incorporate these determining factors in the design and implementation stages, which is vital for the successful implementation of mobile learning. This study will provide that information. This information provides the means to make effective economic and educational decisions concerning mobile learning. If rural high school STEM learners, their teachers, and parents reject mobile learning offered to them, they will not utilize it to improve learners' performance in STEM-related subjects. The result would be wasted budgetary expenses.

1.7.3 Methodological Potential Contribution

The study intent to come up with models that can be used to understand and predict the acceptance of mobile learning by rural high school STEM learners, their teachers, and parents. These models would be able to show the interrelationships between the Technology Acceptance Model and its external variables in the acceptance of mobile learning in a rural context.

1.8 Limitations

The findings of the current research need to be considered in light of its limitations.

- The study was only limited to rural high schools. To get a clearer picture of the acceptance both rural and urban areas of South Africa should be considered.
- Only grade 12 learners, their teachers, and parents were the participants in the current research and therefore generalizing the findings of this study to all grades of rural high school should be done with caution.

- Only STEM learners, their teachers, and parents were considered in this study, meaning that generalizing the findings of the research to other departments, such as commerce and general classes, should be carefully done.

1.9 Organization of the Study

This dissertation consists of eight chapters, including this one. Chapter 2 reviews the existing literature on the acceptance of mobile learning. Chapter 3 is the second part of the literature review. The first part focuses on the existing models that are commonly used in predicting users' acceptance of mobile learning. The subsequent part focuses on the conceptual framework of the study. Chapter 4 outlines the methodology and approach. This part gives some justifications on why the study was carried out the way it was. Chapter 5 presents the findings of the quantitative data and it is followed by Chapter 6 which presents the results of the qualitative data. Chapter 7 reflects on both quantitative and qualitative data and draws noticeable issues and meaning from them. Chapter 8 presents the recommendations and limitations of the study and conclusion.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

This chapter reviews the relevant literature for this research. The study is aimed at assessing the determinants of rural high school STEM learners', their teachers', and parents' acceptance of mobile learning. The definition of Science, Technology, Engineering, and Mathematics (STEM) education is defined in this chapter. The chapter also discusses the nature of the STEM curriculum in South Africa and the challenges that STEM education is facing. The attributes of rural high schools are also presented. The chapter also gives the definitions of mobile learning, its benefits, its acceptance for STEM learning, and its use to mitigate the challenges of STEM education in rural areas. The chapter concludes by discussing factors that rural high school STEM learners, their parents, and teachers consider important when accepting mobile learning for STEM learning.

2.2 Science, Technology, Engineering, and Mathematics (STEM) Education

The integration of Science, Technology, Engineering, and Mathematics (STEM) education is a burgeoning area in both developed and developing countries (El-Deghaidy & Mansour, 2015). Despite STEM's fast growth, there is a lack of an internationally accepted definition of STEM education (English, 2015). Burke, Francis, and Shanahan (2014, p. 4) defined STEM education as "fostering sustained engagement with the STEM disciplines where students can become competent contributors and critical participants in a range of STEM-related activities". In contrast, the STEM Task Force Report (2014, p. 9) in America, adopts the strong view that STEM education is "far more than a 'convenient integration' of its four disciplines, rather, it encompasses 'real-world, problem-based learning' that integrates the disciplines through cohesive and active teaching and English learning approaches". Based on these two definitions, STEM education aims at shifting teaching practices from teacher-centred into learner-centered, problem-based learning, inquiry, and project-based learning, as a means to present interdisciplinary meaningful learning experiences. The conclusion that can be drawn from the STEM education definition by Burke et al. (2014, p. 4) is that, in America and other developed countries, the

STEM curriculum aims to teach learners to collaborate, integrate the four disciplines, and not to teach in insolation, as they do not exist separately in the real world.

2.2.1 The Nature of South African's Science, Technology, Engineering and Mathematics (STEM) Curriculum

Like other developing countries, STEM education is still in its infancy in South Africa (El-Deghaidy & Mansour, 2015). Thus, unlike in developed countries that have a STEM curriculum from pre-school to university (Richard, 2017; National Research Council, 2011), there is no single document that comprises the STEM curriculum.

However, there are subjects that learners can engage in during their school life which are under STEM education. These subjects are Technology, Natural Science and Mathematics, at a senior General Education and Training (GET) level and they are compulsory for all learners, both in rural and urban areas. At the Further Education and Training (FET) level, subjects that fall under STEM education, that are common in rural areas, are Mathematics, Physical Sciences, and Life Sciences. Each subject has its own curriculum and as a result, they are also taught in isolation. The following subsections summarize the curriculum of the aforementioned subjects.

2.2.1.1 Technology

The aim of the subject of Technology is to contribute towards students' technological literacy by providing them with chances to develop and make use of specific design skills to solve real problems (DoE, 2011e). This subject intends to introduce students to FET subjects like Civil Technology, Electrical Technology, and Mechanical Technology. The main topics covered in Technology are the design process skills, structures, processing of materials, electrical systems and control, mechanical systems and control, and technology, society, and environment. For these topics, electrical systems and control and processing of materials need to make use of equipment from a science laboratory. Structures and mechanical systems and control need special equipment that should be kept in the technology room. The assessment is divided into two parts: the practical which makes up 70% and theory which makes up 30% of the final mark (DoE, 2011e).

2.2.1.2 Natural Sciences

The aim of Natural Sciences at the senior phase level is to lay the foundation of further studies in more specific STEM-related subjects like Earth Sciences, Life Sciences, Physical Sciences, and Agricultural Sciences (DoE, 2011d). Natural Sciences have four topics to be covered which are: Life and living (Life Sciences), matter and materials (Chemistry), energy and change (Physics), and planet Earth and beyond (Geography). Energy and change and matter and materials require science laboratory equipment. In contrast, life and living and planet Earth and beyond requires Life Sciences models and geographical models. Formal assessment for Natural Sciences is divided into tests and practical investigations. Tests weigh 60%, while practical investigation weighs 40% of the final mark (DoE, 2011d).

2.2.1.3 Mathematics

Mathematics aims to develop students' fluency in computation skills, without depending on the use of calculators, understand and work with numbers and to develop in students' ability to be methodical, make conjectures, and try to justify or prove them (DoE, 2011c). The topics that are taught are, functions, statistics, number patterns, sequences, series, algebra, finance, differential calculus, Euclidean geometry and measurement, probability, analytical geometry, and trigonometry.

2.2.1.4 Life Sciences

The subject of Life Sciences is described as the scientific study of living things. Life Sciences is divided into the following knowledge strands: Cellular and tissue level, environmental studies, life processes in plants and animals, and diversity, change and continuity (DoE, 2011b). Life sciences learners are required to do practical experiments/activities as part of their informal assessment. For formal assessment, 25% comes from practical activities, while 75% comes from theory in the form of tests and assignments (ibid).

2.2.1.5 Physical Sciences

Physical Sciences aims to enable learners to be able to investigate the physical and chemical processes. This is accomplished through scientific inquiry, and the application of scientific models and laws to explain scientific concepts. The main knowledge areas covered in Physical Sciences are matter and materials, waves, sound and light, mechanics, and electricity and magnetism (DoE, 2011a). All these topics require at least two informal experiments. For formal assessment, 25% comes from experiments and 75% comes from theory, in the form of tests.

The general aims of these curricula of different subjects are to develop learners who have reflective and problem-solving skills, understand the nature of science, and understand the relationship between technology and science. These general aims can only be realized in an environment that has a fully functional science laboratory, where learners do their experiments. However, this is not practical in the rural context in which this study was conducted. The next section describes the attributes of rural high schools that make it difficult for learners to gain the skills that these curricula intend to teach learners.

2.2.2 Attributes of South African Rural High Schools

Researchers do not view and describe rural areas in the same way (Gardiner, 2008; Kelly & Fogarty, 2015). The DoE defined rural in terms of demographic patterns, economic activities, settlement, socio-cultural activities, or historical factors (DoE, 1995). Kelly and Fogarty (2015) defined rural areas in terms of poor infrastructure, low population size, socio-cultural factors, and low economic activities. Based on the two definitions (DoE, 1995; Kelly & Fogarty, 2015), the current study defines rural areas as areas with low economic activities, low population density, and poor infrastructure. Therefore, schools that are situated in areas that experience these factors, as listed by the DoE (1995) and Kelly and Fogarty (2015), are rural. In the study, “rural high school” refers to high schools that are situated in a remote area, with low socioeconomic activities, poor infrastructure, low population density, a high unemployment rate, either limited or unavailability of resources. The next subsections discuss the attributes of rural schools.

2.2.2.1 Low Population Density

There is a low population density in rural areas. This results in the government building a few high schools in these areas. However, each high school would have a very large catchment area and learners would have to walk very long distances to school every day. This is just one challenge in many to learners who are tired before they have even started STEM learning.

2.2.2.2 Large Classes

Low population density also leads to 'larger classes'. National Research (Council), 2005), defined larger classes in terms of learner-teacher ratio. The DoE agreed upon a learner-teacher ratio of 35:1 in secondary schools (DoE, 2001). However, this goal has not been reached in practice, as the study by Onwu and Stoffels (2005) revealed that the average mathematics and science classes in rural areas had a learner-teacher ratio of 60:1. The reason for these large classes in rural areas lays in the way the learner-teacher ratio is calculated (Randall, 2008). The learner-teacher ratio is calculated by dividing the total number of learners in a school by 35, to get the number of teachers (Nilsson, 2003).

Due to the perceived employment opportunities in doing STEM-related subjects, many learners choose to do STEM-related subjects in grade 10. This makes other classes such as commerce classes have a learner-teacher ratio less than 35:1, while science classes are above the learner-teacher ratio of 35:1.

Large classes are also described as "one where the majority of characteristics and conditions present themselves as interrelated and collective constraints, that impede meaningful teaching and learning" (Onwu, 1999, p. 129). Onwu and Stoffels (2005) described other conditions that impede STEM teaching and learning such as shortages of learning materials and science equipment, lack of science laboratories, lack of individual learner attention, and extreme marking load.

2.2.2.3 Limited Availability of Resources

The rural schools are funded by both government and parents (Randall, 2008). The funding from the government is used for the day-to-day running expenses of high school (Ibid). The parents supplement the money supplied by the government to improve the infrastructure and quality of education. Due to the high unemployment rate and low socioeconomic activities in rural areas, most parents do not afford to pay school fees. This leads to rural high schools to be severely under-resourced. Most rural high schools lack; learning materials, science laboratories, furniture, science equipment, and textbooks (Makgato, 2007; Onwu & Stoffels, 2005).

2.2.2.4 Teachers Who are not Qualified to teach STEM-related Subjects

A study by Modisaotsile (2012) confirmed the findings of Onwu and Stoffels (2005) that most science and mathematics teachers in rural areas are either poorly qualified or not qualified to teach these two subjects. The reason may be due to the number of teachers allocated to schools by the DoE using the learner-teacher ratio. In schools where there is low enrolment, the number of teachers provided by the DoE might not be enough for the curriculum needs of the school. Therefore, teachers end up teaching subjects they are not qualified to teach.

Modisaotsile (2012) attributed the problem of having many unqualified teachers in rural areas to teacher transfers. Qualified teachers in rural areas transfer to urban areas where there are better working conditions. A study by Onwu and Stoffels (2005) revealed that out of 49 mathematics and science teachers who participated in the study, four had no qualifications at all, 21 only had grade 12 school certificates, 17 had a three-year diploma, and only 7 held a four-year teachers’ diploma or better.

The aforementioned attributes of rural high schools impede successful STEM teaching and learning. This study needs to highlight the attributes of rural high schools because it is in this environment that rural STEM learners and teachers find themselves. The attributes of rural high schools lead to some of the challenges that STEM education is facing in South Africa. The next section discusses the challenges that STEM education is facing.

2.2.3 Challenges in STEM Education in South African Rural High Schools

2.2.3.1 Challenges in STEM Education in the Senior Phase

Natural Sciences (NS), Technology, and Mathematics are taught as compulsory subjects for all learners in grades 8 and 9 (General Education and Training phase). From grades 10 to 12, the Further Education and Training phase (FET) learners are taught mathematics and sciences only if they choose a science stream. In most rural schools, Mathematics, Physical Sciences, and Life Sciences are common science subjects that learners choose (DoE, 2016).

In the GET phase, NS is taught as one subject, wherein textbooks and classes include Geography (planet earth and beyond), Life Sciences (life and living), Chemistry (matter and materials), and Physics (energy and change) (DoE, 2011d). The topics matter and materials and energy and change need teachers and learners to use a science laboratory to carry out experiments. However, most high schools in South Africa do not have science laboratories (Bezuidenhout, 2013), especially in rural areas (Jantjies & Joy, 2015; Prinsloo & Janks, 2002). As a result of the lack of science laboratories, teaching and learning of NS in these schools are dependent on paper-based learning material, and schools cannot offer learning material apart from this (Jantjies & Joy, 2015). It may be noted that effective teaching and learning of NS in most rural high schools is affected by the lack of science laboratories and equipment to carry out experiments.

Technology education is envisioned to introduce “learners to the basics needed in civil technology, mechanical technology, electrical technology, and engineering graphics and design.” (DoE, 2016, p. 8). Additionally, learners are taught how engineers apply scientific principles to solve practical problems (ibid). The Technology Curriculum and Assessment Policy Statement document suggests that each school should have a technology room fitted with information and communication technology equipment, and tools to support hands-on project-based learning (DoE, 2016). However, most rural high schools lack basic material necessities such as classrooms and furniture Prinsloo and Janks (2002), which makes it nearly impossible for these schools to have a room reserved for technology. One may conclude that in these conditions, the intention of STEM education of engaging learners with the STEM disciplines where they may become skilled contributors and participants in STEM-related fields may not be successfully met. This was supported by Maravanyika (1986) who stated that poor and insufficient facilities add to the problems that prevent successful implementation of technology in schools.

Another challenge with Technology education in rural areas is that it is taught by teachers who are not qualified to teach it (Nokwali, Mammen, & Maphosa, 2015). In some schools, the enrolment is very small, such that a limited number of teachers are allocated to the affected schools. In these situations, schools will be allocated teachers whose subjects are offered both at the GET and FET. Since Technology ends at the GET phase, the schools end up allocating Technology education to any teacher to balance the duty load (Nokwali et al., 2015).

When it comes to the implementation of STEM in the senior phase, it is noticed that teachers prepare and deliver their lessons individually (El-Deghaidy & Mansour, 2015). The author went on to state that it is rare for science, mathematics, and technology teachers to sit together and identify cross-cutting content (ibid). The lesson that may be drawn from the studies of (El-Deghaidy & Mansour, 2015; Nokwali et al., 2015) is that the four disciplines of STEM education (mathematics, technology, science, and engineering) are taught in isolation in rural areas, which is against the suggestions made in the report which stated that STEM education is an integration of four disciplines and should not be taught in isolation(STEM Tusk Force Report, 2014).

2.2.3.2 Challenges in STEM Education in the FET Phase

Makgato (2007) conducted a study to explore the factors that are associated with poor performance in Mathematics and Physical Sciences in South African townships and rural schools. The author identified the following factors as major contributors to learners' poor performance in Mathematics and Physical Sciences; lack of science laboratories and practical experiments, lack of parental involvement, lack of proper teaching, lack of learner motivation, and interest in the subjects. Makgato (2007) also attributes poor performance in Mathematics and Physical Sciences to these subjects being considered as boring and difficult.

The majority of rural high schools that offer Mathematics and Physical Sciences at FET level do not have science laboratories and equipment to enhance effective teaching and learning (Bezuidenhout, 2013; Jantjies & Joy, 2015; Makgato, 2007). In a few schools where the science laboratories are available, they are not fully equipped with apparatus that may be used for teaching and learning (Makgato, 2007). For a few schools which are fortunate to have the equipment, only the teacher demonstrates without learners doing the experiments themselves. In these circumstances, teaching and learning of Physical Sciences remain mostly at a theoretical level without any experiments to augment the understanding of science concepts. Learners' participation in laboratory and practical activities plays a crucial part in developing scientific concepts and problem-solving (Bosman & Schulze, 2018; Lunetta, 1988). The author added that learners should do the experiments themselves to develop a positive attitude towards Physical Sciences.

To be in line with the suggestion of Lunetta (1988) who stated that learners should do experiments themselves, the Department of Basic Education changed formal assessment requirements for Physical Sciences from practical investigation to experiments (DoE, 2011a). The DoE urged that the knowledge and skills concerning laboratory apparatus are examined in the Grade 10 to 12 examinations. These knowledge and skills are also valued by universities in the STEM-related fields (DoE, 2011a). With practical investigation, learners and teachers could do them without the need of having the science laboratory and equipment, which was easy for STEM teachers and learners in rural areas. With the introduction of experiments, teachers and learners in rural areas face a big challenge in meeting the school-based continuous assessment requirements. In some cases, teachers transport their learners to neighbouring schools with science laboratories or share laboratory resources (Makgato, 2007).

Mathematics and Physical Sciences are practical learning areas whose teaching and learning should always reflect practice. Doing experiments is very important as it increases learners' problem-solving skills, enhances the understanding, improves learners' interest towards Physical Sciences and also helps them remember science concepts (DoE, 2011a; Makgato, 2007). Based on the studies of (Bezuidenhout, 2013; DoE, 2011a; Jantjies & Joy, 2015; Makgato, 2007), one may conclude that rural high schools are faced with a lack of science laboratories and equipment challenges, which hinders effective teaching and learning of STEM-related subjects.

Makgato (2007) noted that schools in rural areas not only lack science laboratories, but they also lack learning materials as well. This was echoed by Visser, Juan, and Feza (2015), who carried out a study on the effect of home and school resources on South African students' Mathematics achievement. The results have shown that learners in rural areas lack study materials and textbooks. The findings also showed that studying materials had a significant effect on learners' achievement in Mathematics. This finding supported the finding of (Berg, 2008), who stated that overcrowded and under-resourced classrooms affect learners' achievement in Mathematics and Physical Sciences.

Learner motivation plays a significant role in poor rural high school students' performance in Mathematics (Chan & Norlizah, 2017; Devlin, 1997; Makgato, 2007; Mupira & Ramnarain, 2017; Ramnarain, 2013). Chan and Norlizah (2017) investigated the effects of learners' motivation towards STEM learning and learners' STEM achievement. The results revealed that learners who were moderately motivated towards STEM learning achieved mid-low achievement in STEM. Rural high school learners are not motivated toward STEM learning (Ramnarain, 2013). (Ramnarain, 2013) attributed the lack of motivation to the deficits in both physical and human resources in rural areas. In contrast, other authors suggested that current teaching strategies in STEM education demotivate learners (Bosman & Schulze, 2018; Devlin, 1997).

The use of appropriate teaching methods plays a critical role in helping learners' understanding of Physical Science (Bosman & Schulze, 2018). The researchers added that continued mismatches between the teaching style and learners' learning preferences in the classroom contribute to poor performance in STEM education. Studies show that when learners consider their learning preferences when studying and are taught in a way that is in line with their learning preferences, their academic achievements seem to improve (Bosman & Schulze, 2018; Breckler, Teoh, & Role, 2011; Naik, 2013). The majority of learners in a classroom are visual learners (Nel & Nel, 2016), who learn effectively through the depiction of information in diagrams. Auditory learners prefer information that is spoken and heard. Consequently, they learn best through lectures and group discussions. This group of learners usually makes up 20% of the class (Juškevičienė & Kurilovas, 2014). Kinaesthetic learners cannot sit for long hours; they learn best by moving and acting (Juškevičienė & Kurilovas, 2014).

Studies in STEM education also noted that rural teachers more often use traditional face-to-face instruction (FTF) which can only cater to 20% of the class (Onwu & Stoffels, 2005). The traditional face-to-face instruction is blamed for failing to stimulate deep, holistic learning experiences (Bosman & Schulze, 2018; Breckler et al., 2011; Caldwell, 2007; Duncan, 2006; Juškevičienė & Kurilovas, 2014; Mji & Makgato, 2006; Naik, 2013). Consequently, STEM education is considered boring and difficult (DoE, 2017, 2018; Ramnarain, 2013).

The DoE (2017) stated that the number of learners doing Mathematics and Physical Sciences decreased and they attributed this trend to the subjects being perceived to be difficult by learners. The performance of learners in Mathematics at 40% or better was 33.5% (2016) and 35.1% (2017). For the same period, the performance at 40% or better in Physical Sciences was 39.5% (2016) and 42.2% (2017). The results confirmed the findings of Ramnarain (2013), who stated that South African learners' performance in Physical Sciences and Mathematics was poor.

In rural settings, the lack of parental involvement in children's education contributes to learners' poor performance in Mathematics and Physical Sciences (DoE, 2014; Makgato, 2007; Modisaotsile, 2012). Modisaotsile (2012) stated that some parents in rural areas cannot read or write and as a result, they cannot help their children with homework. The researcher also noted that some parents work in towns and they come home only on weekends, while some go to work very early in the morning and come back late in the evening tired, and cannot check if their children's homework is done properly. Studies have shown that learners whose parents are involved in their learning outperform their counterparts in Mathematics and Science whose parents are not involved (Castro et al., 2015).

Poor time management contributes to high failure rates in STEM-related subjects in rural areas (Makgato, 2007; Mashaba & Maile, 2018; Mboweni, 2014). Mboweni (2014) noted that a lot of notional time is lost due to high rates of learner absenteeism. The researcher noted that poverty, social grants pay out days, lack of parental involvement, teenage pregnancy, and unstable family backgrounds are the main cause of learners' absenteeism in rural areas.

Mashaba and Maile (2018) noted teacher absenteeism as one of the main contributors to poor time management in rural areas. The researchers noted that teacher absenteeism is caused by teachers getting into the classroom late or leaving the classroom early, attending union meetings, workshops, experiencing transport problems, and violence in schools. Modisaotsile (2012) noted that teachers in rural areas teach an average of 3,5 hours, whereas their counterparts in urban areas teach an average of 6,5 hours a day. Based on the studies of Modisaotsile (2012), Mboweni (2014), and Mashaba and Maile (2018), one can conclude that in rural high schools there is much notional time lost, caused by both teachers and learners.

The STEM education in rural areas is faced with many challenges (Bosman & Schulze, 2018; Chan & Norlizah, 2017; DoE, 2014; Makgato, 2007; Modisaotsile, 2012; Ramnarain, 2013). Makgato (2007) found that a lack of science laboratories and a lack of motivation affect STEM education in rural areas. STEM education in rural areas is also affected by teachers' incorrect teaching strategies and STEM education being perceived as boring and challenging (Bosman & Schulze, 2018; DoE, 2014). Furthermore, a lack of parental involvement, poor time management, and teachers teaching STEM subjects they are not qualified to teach contribute to the challenges of STEM education in rural areas (Modisaotsile, 2012; Nokwali et al., 2015).

2.2.4 The Use of M-learning to Mitigate the Challenges in STEM Education

Studies have shown that M-learning can be used to mitigate the challenges of STEM education (Tsuei & Hsu, 2019; Yan & Lin, 2005). For instance, a parent's involvement affects the learner's achievement in STEM education (Yan & Lin, 2005). Yan and Lin (2005) studied the effects of parents' involvement on learners' achievement in Mathematics. The results showed that parental involvement had a direct effect on their children's mathematics achievement. This finding was supported by the finding of (Jeynes, 2003; Park & Holloway, 2017; Sheldon, 2003; Tsuei & Hsu, 2019), who collectively found that involving parents in children's STEM learning improve learner's performance. The lesson that can be learnt from these studies is that parent involvement in STEM education in rural areas will improve learners' achievement (Jeynes, 2003; Sheldon, 2003; Tsuei & Hsu, 2019; Yan & Lin, 2005). Studies have shown that mobile learning improves parents' involvement in their children's education (Kong, 2018; Lewin & Luckin, 2010; Özdamli & Yildiz, 2014).

Mobile learning improves the partnerships between schools and families (Kong, 2018). Mobile learning is considered more immediate, convenient, and effective than traditional outreach models (Blau & Hameiri, 2017; Goodall, 2016; Wasserman & Zwebner, 2017). Kong (2018) stated that parents perceive the usefulness of M-learning and the less effort needed to use M-learning as the main factors that increase their participation in their children's learning.

Mobile learning brings many advantages in the STEM classroom, such as studying material will be more accessible and flexible (Criollo-C, Luján-Mora, & Jaramillo-Alcázar, 2018). Learning material that includes notes, textbooks, past examination papers and their marking guidelines, and Mathematics and Sciences intervention study materials are available on the Department of Basic Education's website (DoE, 2017). These are the learning materials that STEM learners in rural areas are lacking. Introducing mobile learning in rural areas can mitigate the challenge by making these learning materials available to STEM learners.

Another challenge that STEM learners in rural areas are facing, which may be alleviated by mobile learning, is poor time management. A lot of time is lost due to teacher absenteeism (Mashaba & Maile, 2018) and learner absenteeism (Mboweni, 2014). Introducing mobile learning in rural areas will minimize time lost. Mobile learning may enable this by ensuring learners access to learning content anywhere at any time (Almaiah, Jalil, & Man, 2016). Mobile learning may also extend learning hours by facilitating teacher-learner and learner-learner communication (Alrajawy, Norzaidi, Isaac, & Mutahar, 2017).

The use of use one teaching style (traditional face-to-face instruction) and the lack of learner motivation are also some of the challenges that STEM education in rural areas is facing. Mobile learning changes lessons from being teacher-centred to learner-centered (Bourgonjon, Valcke, Soetaert, & T. Schellens, 2010; Koehler & Mishra, 2016; Prensky, 2001b). Mobile learning is a tool that provides teachers with many different teaching methods such as educational games (Gedik, Hanci-Karademirci, Kursun, & Cagiltay, 2012), quizzes, access to mobile virtual worlds (F Ferreira, Dias, Braz, Santos, Nascimento, Ferreira, & Martinho, 2013), and group work (Yeap, Ramayah, & Soto-Acosta, 2016). According to Yeap et al. (2016), mobile learning appeals to a new generation of learners who likes to use mobile devices. Furthermore, mobile learning motivates learners in their school work (Camilleri & Camilleri, 2019). Lessons that can be drawn from Bourgonjon et al. (2010), Camilleri and Camilleri (2019), and Gedik et al. (2012) are that mobile learning enables teachers to use different pedagogies to cater for learners' needs and it can motivate learners to do their school work. It may be concluded that introducing mobile learning in rural areas will enable teachers to use different teaching methods to meet the different learning needs of learners.

Mobile learning enables learners to visualize science experiments using videos. Jager (2012) stated that visual media may be blended with traditional approaches when teaching. Salomon (1994) proved that learners learn new concepts and abstracts using verbal and visual forms. For example, mobile learning enables a teacher to record an experiment and send it to learners. Introducing mobile learning in rural areas will mitigate the challenge of insufficient or ineffective science laboratories by allowing the visualization of the experiment. According to Salomon (1994), visual media enables learners to recall information. Visualizing science experiments may positively affect learners' knowledge of science (Pinker, 1997), which enables them to give full explanations of scientific concepts (Bransford, Brown, & Cocking, 1999).

Based on the studies of Alrajawy et al. (2017), Bourgonjon et al. (2010), Bransford et al. (1999), Criollo-C et al. (2018), Kong (2018), and Tsuei and Hsu (2019), one can conclude that even though STEM education is faced with a lot of challenges, mobile learning may help to reduce the impacts of those challenges. Introducing mobile learning in rural schools for STEM education will provide learners with access to learning materials and video experiments which enable them to visualize these experiments (Bransford et al., 1999, Jager, 2012, Salomon, 1994). Mobile learning in rural areas will provide easier and faster communication with parents, which may improve parent's participation in their children's education (Criollo-C et al., 2018; Kong, 2018). Learning and teaching can happen anytime and anywhere using mobile learning and hence reduce teaching and learning time lost (Alrajawy et al., 2017). Introducing mobile learning in rural areas will bring fun and easy collaboration and motivate learners to do their work (Tsuei & Hsu, 2019).

2.3 Mobile Learning Definition

Tertiary education institutions, schools, and other education institutions are motivated when they have constant access to wireless technology to use mobile devices for teaching and learning (Donaldsom, 2011; Lam et al., 2011). According to Donaldson (2011, p. 14), motivation is supported by the advances in wireless networks and mobile technology, making mobile devices reasonably priced for an average person. Mobile technologies offer STEM learning opportunities in the classroom and beyond. As a result, its use has grown in the past two decades (Buedding & Schroer, 2009; Leung & Chan, 2003). These devices facilitate parent-teacher and learner-teacher communication and interaction (Chen, Teo, & Nguyen, 2019; Zhu et al., 2018). Furthermore, they enable rural, high school STEM learners to learn anywhere, anytime, and exchange information outside of the classroom (Lam, Wong, Cheng, Ho, & Yuen, 2011).

Mobile learning is defined as learning which makes use of wireless devices like iPods, laptops, smartphones, USBs, cameras, and PDAs (Lu & Viehland, 2008). Keegan (2005) defined it, in terms of mobility, as the provision of education and training using devices that are easy to carry and use anywhere, at any time, like smartphones, PDAs, and palmtops. Mobile learning was also defined as an extension of e-learning by Pinkwart, Hoppe, Milrad, and Perez (2003), who defined it as e-learning facilitated by wireless mobile devices. In the current study, mobile learning is defined as the use of wireless mobile devices like smartphones, tablets, iPods, laptops, and USBs by rural high school STEM learners and teachers for teaching and learning of STEM-related subjects.

2.4 Benefits of Mobile Learning to STEM Learning

Mobile devices facilitate communication between STEM teachers and learners, learners and their peers and teachers and parents (Brandt, Hillgren, & Bjorgvinsson, 2009; Kiger & Herro, 2015). Mobile learning helps STEM learners to collaborate and learn from each other outside of the classroom. STEM learners can share learning multimedia resources, such as eBooks, web pages, PowerPoint presentations, word documents, videos, and audios (Shih, Chu, & Hwang, 2011). The communication between STEM teachers and parents helps with improving parental involvement in their children’s education, which in turn, improves their children’s performance (Tam & Chan, 2009).

Mobile devices allow STEM learners to learn in real-life contexts, as mobile devices can operate as capturing tools (Lan & Tsai, 2011). Mobile devices allow STEM learners to capture photos of the classroom, videos, and photos of field trips, record lecture episodes and record audio conversations and narrations (Hoban, 2009). All these functions are brought about by powerful cameras and voice recording abilities in these mobile devices. After capturing all this information, STEM learners can use the same mobile devices as a representational tool to create representations to present their experiences (Marty, Douglas, Southerland, Sampson, Alemanne, Clark, A Mendenhall, Paz et al., 2012). STEM learners can also use mobile devices as analytical tools for manipulating certain data or variables (Maldonado & Pea, 2010). Mobile devices can also be used as assessment and revision tools. STEM learners can make use of mobile devices to take examinations, tests, or quizzes. They can also access revision materials and train themselves before writing their examinations. After revision or examinations, STEM learners can store past examination papers, eBooks, contact information, task lists, and homework submissions (Segall, Doolen, & Poter, 2005). However, for STEM learners to benefit from M-learning, they should accept and adopt it. The next subsection highlights the acceptance of M-learning for STEM learning.

2.5 Acceptance of Mobile Learning for STEM Learning

Numerous studies have been carried out to explore the benefits of mobile learning on STEM learners' motivation, attitudes or beliefs, leadership, and performance (Bazelais & Doleck, 2018; Males et al., 2017; Pournara, Hodgen, Adler, & Pillay, 2015; USDOE, 2017; Zheng, Warschauer, Lin, & Chang, 2016). The results have shown that the question should be how mobile learning may improve STEM learning, rather than whether it should be used (USDOE, 2017). Tallvid, Lundin, Svensson, and Lindström (2015) stated that M-learning has the potential to be an influential tool for enhancing STEM teaching and learning. As a result, in countries like the USA, many schools have opted to provide learners with laptops, to use both at school and home (Léger & Freiman, 2016).

The technology acceptance model (TAM) has received theoretical and empirical support in the body of knowledge (Padilla-Meléndez, Aguila-Obra, & Garrido-Moreno, 2012). TAM was developed by (Davis, 1989) based on the theoretical grounding of the theory of reasoned action. TAM was developed to predict users' acceptance of the technology. TAM assumes that behaviour intention to use the system predicts the system's acceptance and use. The behaviour intention to use a system is determined by attitudes, perceived ease of use (PEOU), and perceived usefulness (PU) (Davis, 1989). Perceived ease of use and perceived usefulness are the primary predictors of acceptance of the system. These two primary predictors are called extrinsic motivators (Padilla-Meléndez et al., 2012), because they result in the user performing an activity to attain valued outcomes, which are different from the activity itself, like improving learner's performance for example. Learners will use mobile learning not because they enjoy using the system, but because they want to improve their performance. TAM was also improved by adding other relevant variables (Binyamin, Rutter, & Smith, 2019; Mohammadi & Mahmoodi, 2019). Some of the variables that were added are intrinsic motivators because they result in the user performing an activity for no other reason other than the process of performing it, for example, perceived enjoyment (Venkatesh, 2000). TAM was also used to predict the acceptance of M-learning (Almasri, 2014; Joo et al., 2018; Mutono & Dagada, 2016; Zhu et al., 2018).

There are 63 factors that influence the acceptance of mobile learning for STEM learning (Kumar & Chand, 2019). Due to the similarities in these 63 factors, researchers have categorized them into 15 major factors (Kumar & Chand, 2019). These major factors include perceived attitude towards M-learning; anxiety; behavioural intention; perceived ease of use; perceived enjoyment; learner interest; prior experience; usefulness; learnability; personal; technological; social influence; financial; pedagogical; and readiness (Kumar & Chand, 2019; Liu, Rao, Liu, & Zhou, 2018; Nikou & Economides, 2016). In a systematic literature review study that was conducted by (Kumar & Chand, 2019), the results showed that the key factors that influence the adoption of M-learning are: perceived attitude towards; behavioural intention; enjoyment; perceived ease of use; experience; perceived usefulness; learnability; and personal and social influence. The results also showed that interest;

anxiety; technological; financial and pedagogical factors have minimal impact on mobile learning acceptance.

2.5.1 Factors that High School STEM Learners Consider Important in the Adoption of M-learning

The STEM learners' perceptions of mobile learning need to be understood before implementation because STEM learners are the ones who are intended to benefit from it and who are also going to use the system. Therefore, the successful implementation of mobile learning in rural high schools hinges on learners' perceptions (Ismail, Azizan, & Gunasegaran, 2016). Hence, studies are needed to understand the factors that high school STEM learners consider important when accepting mobile learning. Several studies examined learners' acceptance of mobile learning (Alhassan, 2016; Iqbal & Bhatti, 2015; Ismail et al., 2016; Khan, Al-Shihi, Al-Khanjari, & Sarrab, 2015; Zhu et al., 2018). However, there is a gap in the literature about factors that influence rural high school STEM learners' acceptance of mobile learning because most of the research had focused on tertiary institutions (Hanif & Asrowi, 2018; Mumba & Lengwe, 2018; Padmanathan & Jogulu, 2018). Furthermore, most of the research was conducted in developed countries. Very little is known about the acceptance of mobile learning by rural high school STEM learners in developing countries.

The STEM learners' perceived attitude towards (ATT) the use of mobile learning has a positive influence on their behavioural intention (Al-Emran, Alkhoudary, Mezhuyev, & Al-Emran, 2019). Similar results were also obtained by (Saroia & Gao, 2018). In the same study, Saroia and Gao (2018) used university learners to investigate their intention to use M-learning management systems. The results showed that attitude towards the use of mobile learning positively affected behavioural intentions. These findings are also congruent with the findings of previous studies (Al-Emran et al., 2019; Iqbal & Bhatti, 2017; Liu et al., 2018; Mutono & Dagada, 2016; Yorganci, 2017).

Learners' perceived ease of use (PEOU) has a positive influence on the intention to accept M-learning (Hao, Dennen, & Mei, 2017; Iqbal & Bhatti, 2017). In another study by (Iqbal & Bhatti, 2017), TAM was extended by adding the following antecedents:

students' readiness; perceived playfulness; university support; self-management of learning; social influence; mobility, and faculty support. The results showed that behavioural intention (BI) to accept mobile learning is positively affected by PEOU. This result is similar to the finding of (Chung, Chen, & Kuo, 2015; Hao et al., 2017). On the contrary, in other studies on factors that affect the adoption of mobile learning, the results showed that the perceived ease of use has an insignificant effect of on the intention of adopting M-learning (Liu, Li, & Carlsson, 2010; Sánchez-Prietoa, Hernández-Garcíab, García-Peñalvoa, Chaparro-Peláezb, & Olmos-Migueláñeza, 2019). The researchers believed these findings were because of a great effort by content designers to create user-friendly platforms. Furthermore, the predictive power of PEOU on behavioural intention is weaker than that of PU (Iqbal & Bhatti, 2017).

Many studies have reported that PEOU has a positive influence on PU, attitude and behavioural intention to use mobile learning (Binyamin et al., 2019; Davis, 1989; Donaldson, 2011; Mohammadi & Mahmoodi, 2019). On the contrary, the findings of a study conducted by Saroia and Gao (2018) showed that PEOU does not predict PU. These results were consistent with the results of (Sánchez-Prietoa et al., 2019), who also reported that PEOU has no significant effect on PU. This can be because of the subjects of the study. University learners in developed countries are generally used to mobile learning and are proficient in using mobile devices.

In educational environments, making the learning process less wearisome and more enjoyable is very important (Huang, 2014). Perceived enjoyment (PEN) was defined as the level to which the use of information system (IS) is pleasurable apart from any performance consequences that may be expected (Al-Adwan, Al-Madadha, & Zvirzdinaite, 2018). Perceived enjoyment in the mobile learning context is defined as the level to which the use of mobile devices is pleasurable, irrespective of the usefulness of these devices on the learner's academic performance. It is an intrinsic motivator because learners are involved in using mobile learning due to their interest in using mobile learning. Rural STEM learners who experience pleasure and gratification during the use of mobile learning are more likely to keep on using it. Previous studies reported that PEN had a positive effect on STEM learners' BI to use mobile learning (Ali & Arshad, 2016; Poong, Yamaguchi, & Takada, 2016). In agreement with Ali and Arshad (2016) and Poong et al. (2016), Al-Adwan et al. (2018) found perceived enjoyment to have a positive influence on behavioural intention to use mobile learning.

In another study, Sánchez-Prietoa et al. (2019) extended the Technology Acceptance Model by adding subjective norm, perceived enjoyment, and compatibility. To test the model, data from 160 pre-services teachers were used. The results showed that perceived enjoyment positively predicts perceived usefulness and perceived ease of use. The behavioural intention was positively influenced by all the antecedents except perceived ease of use. Furthermore, the study also revealed that perceived enjoyment predicts behavioural intention to use mobile learning better than perceived usefulness. However, these results are inconsistent with the findings of some studies (Iqbal & Bhatti, 2017; Mutono & Dagada, 2016; Zhu et al., 2018), that stressed that perceived attitude towards the use is the best predictor of behavioural intention followed by perceived usefulness.

The STEM learners' behavioural intention to accept and use mobile learning is positively influenced by perceived usefulness (Aburub & Alnawas, 2019; Cheng, 2019; Davis, 1989; Lu & Viehland, 2008). Similar results were found by (Mutono & Dagada, 2016) in South Africa, who investigated university learners' adoption of M-learning. The researchers extended the TAM by adding learners' readiness and concluded that learners' behavioural intention to adopt mobile learning is positively affected by their perceived usefulness. Perceived usefulness was found to be the major determinant of behavioural intention; these findings are consistent with the results of other studies conducted by (Davis, 1989; Liu et al., 2018; Mohammadi & Mahmoodi, 2019; Yorganci, 2017).

Liu et al. (2018) extended the TAM by adding self-efficacy as one of its external variables. Self-efficacy is defined as the self-confidence an individual has in his or her own ability to complete a task and reach goals (Huang, 2014). Self-efficacy shares a similar definition with this study's skills readiness, which is defined as one's perception of his or her capability to use a mobile device in a mobile learning environment for the accomplishment of a learning task (Akour, 2009). In the mobile learning context, individuals who possess the required skills to use mobile devices have high self-confidence in their ability to complete a task. The results show that self-efficacy has a positive effect on perceived usefulness (Liu et al., 2018). Other researchers (Mohammadi & Mahmoodi, 2019; Park & Chen, 2007; Yorganci, 2017) also found similar results as that of Liu et al. (2018).

In another study conducted by Mutono and Dagada (2016), the results showed that skills' readiness and psychological readiness have a positive influence on both perceived ease of use and perceived usefulness. On the contrary, Yorganci (2017) found that self-efficacy does not affect perceived ease of use. However, both were conducted in a tertiary institution, not in a rural high school.

In a study conducted by (Sivo, Ku, & Acharya, 2018), the Technology Acceptance Model was extended by adding perceived resources (PR). The researchers collected and analysed data from 115 university learners. The results showed that perceived resources had a positive effect on perceived usefulness. These findings were consistent with the pre-test results of the study by (Ku, 2009), who reported that perceived resources influences perceived usefulness. However, the results were inconsistent with the post-test results of Ku (2009), who reported that perceived resources had no significant effect on perceived usefulness.

In the study by Sivo, Ku, and Acharya (2018), the results also showed that perceived resources had no significant influence on behavioural intention to use mobile learning. However, the results are in contradiction to the results found by (Mtebe & Raisamo, 2014). Mtebe and Raisamo (2014) used the Unified Theory of Acceptance and Use of Technology (UTAUT) model to study learners' behavioural intention to adopt and use mobile learning in tertiary education. Data from 823 learners were collected and analysed. The results showed that facilitating conditions (perceived resources) had significant positive effects on learners' behavioural intention to use mobile learning. The study also revealed that, contrary to the belief that resources are very limited in developing countries (Thomas, Singh, & Gaffar, 2013), 93% of the STEM learners stated that they had access to the internet via mobile devices. Additionally, the study revealed that perceived resources had a significant effect on perceived usefulness. Similar results were also found by (Ku, 2009). In the study, Ku (2009) extended the Technology Acceptance Model by adding perceived resources. The results showed that perceived resources had a significant effect on both perceived ease of use and perceived attitude towards the use of mobile learning.

Pramana (2018) combined constructs from the Unified Theory of Acceptance and Use of Technology, the Technology Acceptance Model, and specific mobile learning constructs to form a new model to explain learners' acceptance of mobile learning. The researchers collected data from 696 urban university learners. The researchers used structural equation modeling (SEM) to analyse the data and to develop the theoretical model using Amos software. Their findings were that perceived usefulness and perceived ease of use were the strongest predictors of behavioural intention. They also found that perceived social influence (PSI) has a significant effect on perceived ease of use and behavioural intention through the mediation effect of perceived usefulness. This finding is consistent with the findings of (Venkatesh, Morris, Davis, & Davis, 2003). Contrary to the finding of Pramana (2018) and Venkatesh et al. (2003) Huang (2014) found that perceived social influence does not have a significant effect on behavioural intention to use mobile learning. Furthermore, perceived social influence's effect on behavioural intention was strongest during the initial stages and decreased over time.

Hamzah and Muchlis (2018) investigated the factors high school learners consider important when adopting mobile learning. The research provided new factors to the body of knowledge which included the availability of content that is related to what the learners are studying on the internet and the encouragement received by learners to use mobile learning from the school and parents. The availability of content needed by the learners falls under learnability, while the encouragement of learners falls under personal (Kumar & Chand, 2019). Other variables that are found under learnability are learning style and facilitating conditions. The results showed that both the availability of content and encouragement received by learners are determinants of mobile learning acceptance. However, due to the descriptive statistics used to analyse the data, it is impossible to assess whether these variables are statistically significant predictors of adoption of M-learning. Furthermore, the findings are in contradiction with the findings of (Nassuora, 2013) who found that facilitating conditions had no significant influence on behavioural intention to use M-learning.

2.5.2 Factors that Rural High School STEM Teachers Consider Important when Accepting Mobile Learning

The factors that rural high STEM teachers consider important when adopting mobile learning are very important for the successful implementation of mobile learning. Rural STEM teachers are the ones who will be presenters, moderators, and/or consultants in the mobile learning environment. Rural high school teachers are also the ones who guide learners and provide learning materials. If rural high school STEM teachers' perspective is ignored, the implementation of mobile learning may not be successful. There are inconsistent results about teachers' acceptance of mobile learning (Chiu & Churchill, 2016). Several studies have reported that teachers do not generally make effective use of information technology in the classroom (Aldunate & Nussbaum, 2013; Hixon & Buckemeyer, 2009; Levin & Wadmany, 2008). However, some studies have indicated that teachers have positive attitudes towards mobile learning (Baran, 2014; Chiu & Churchill, 2016). Furthermore, there are limited studies about rural high school STEM teachers' acceptance and use of mobile learning (Cheung & Hew, 2009).

Studies showed several factors that influence rural STEM teachers' acceptance of mobile learning. These factors include perceived resources (that is the availability of connection, cost, technical and pedagogical skills); perceived enjoyment, perceived ease of use; perceived ease to collaborate (PEC); perceived usefulness; perceived attitude towards; perceived psychological readiness (PPR), and behavioural intention (Kim, 2013; Kumar & Chand, 2019; Mohammadi & Mahmoodi, 2019; Sánchez-Prietoa et al., 2019; Tsuei & Hsu, 2019).

In the study by (Callum, Jeffrey, & Kinshuk, 2014), the researchers extended the Technology Acceptance Model by adding the following variables digital literacy;

information and communications technology (ICT) anxiety; and information and communications technology teaching self-efficacy to investigate lecturers' behavioural intention to adopt mobile learning. Digital literacy was defined by the researcher as, "the measure of an individual's ability to use digital technology, communication tools, and/or networks to access, manage, and integrate digital resources" (Callum et al., 2014, p. 145). This definition is closely related to skills readiness.

Information and communications technology anxiety was defined in the study as the feeling of discomfort, apprehension, and fear of coping with information and communications technology tools or uneasiness in the expectation of negative outcomes from computer-related operations (Rahimi & Yadollahi, 2011, p. 204). Information and communications technology anxiety inversely correlates with psychological readiness. If one is psychologically ready, it means one has no fear of the unknown and has the confidence to cope with changes. When rural high school STEM teachers become more psychologically ready for the use of mobile learning in the classroom, they will stop feeling anxious about its use (Cowan & Jack, 2011). Lastly, information and communications technology teaching self-efficacy describe teachers who view technology as an effective way to enable student learning and perceive it as a useful medium to support their learning (Callum et al., 2014, p. 146).

The researchers collected data from 175 lecturers and analysed them (Callum et al., 2014, p. 146). The results confirmed the influence of perceived usefulness on adoption and use mobile learning (Adams, Nelson, & Todd, 1992; Binyamin et al., 2019; Davis, 1989). However, perceived ease of use showed no significant effect on behavioural intention. Additionally, the study also showed that digital literacy (skills readiness) had a major influence on behavioural intention, perceived usefulness, and perceived ease of use. The same study also revealed that perceived usefulness and perceived attitude towards had a positive effect on the behavioural intention to use M-learning (Callum et al., 2014). Similar findings were also reported by Odiakaosa et al. (2017) who investigated the factors that rural teachers consider when adopting mobile learning. The researchers collected data from 24 teachers in the Hardap region in Namibia. The results showed that all teachers perceived the use of mobile devices in the classroom as useful. This was demonstrated by 100% of teachers agreeing that their learners' grades would increase because of using mobile learning. However, the descriptive analysis method used by Odiakaosa et al. (2017) makes it difficult to tell if teachers' perceived usefulness has a significant effect on their behavioural intention to use mobile learning.

The perceived ease of use has a significant effect on behavioural intention to use mobile learning (Callum et al., 2014). This finding confirmed the results of a prior study (Donaldson, 2011). The finding was also confirmed by more recent studies (Sánchez-Prietoa et al., 2019; Saroia & Gao, 2018) which stated that perceived ease of use does not necessarily have a direct impact on behavioural intention. On the contrary, other studies (Alshmrany and Wilkinson (2017); Kumar, Rose, and D'Silva (2008)) reported that perceived ease of use had a significant effect on behavioural intention. The researchers also found that perceived ease of use predicted behavioural intention better than perceived usefulness, which is again in contradiction to the results of other researchers (Donaldson, 2011; Sánchez-Prietoa et al., 2019; Saroia & Gao, 2018).

In another study by (Alshmrany & Wilkinson, 2017), computer literacy was defined as the individual's judgment of his or her capacity to use the computer confidently, which is not only concerned with the skills one has, but with the judgments of what one can do with whatever skills one possesses. This definition is similar to this study's skills' readiness. Alshmrany and Wilkinson (2017) collected data from 170 teachers. The findings showed a very strong significant relationship between computer literature effect and effort expectancy (perceived ease of use). The interviews that were carried out in the study also supported the finding that teachers expressed that they would be able to express their ideas to learners using less information and communication technology effort. These findings were consistent with the findings of Fathema, Shannon, and Ross (2015), Ong and Lai (2006), and Park (2009), who collectively found that perceived ease of use influences behavioural intention.

In the same study, computer literacy was found to have a weak to no significant effect on performance expectancy (PU) (Alshmrany & Wilkinson, 2017). The teachers who were interviewed stated that even though they know how to use information and communication technology for teaching, their performance depends on classroom conditions, knowledge of the subject, and personal credibility not just on the operating information and communication technology facilities. However, this finding is in contradiction with the results of other researchers who found computer literacy to have a significant influence on perceived usefulness, which in turn, is a determinant of information and communication technology acceptance (Fathema, Shannon, & Ross, 2015; Fathema & Sutton, 2013; Park, Nam, & Cha, 2012).

Alshmrany and Wilkinson (2017) revealed that information and communication technology anxiety has a negative effect on behavioural intention. Very few previous studies have investigated the effect anxiety has on mobile learning. However, some studies have looked at the effect anxiety has on behavioural intention to use information and communication technology in the classroom (Rahimi & Yadollahi, 2011; Teo, 2011; Wang, 2007; Wilfong, 2006). In the studies of Teo (2011) and Wilfong (2006), the researchers found that teachers' information and communication technology anxiety negatively affects their adoption and use of information and communication technology in the classroom. When a person has information and communication technology anxiety, it means that he or she is not psychologically ready for information and communication technology use in the classroom (Mutono & Dagada, 2016). Information and communication technology anxiety shows that a person is not psychologically ready for the use of information and communication technology in the classroom. Therefore, it also follows that psychological readiness positively influences the behavioural intention to use mobile learning. Rural high school STEM teachers who are psychologically ready will not have a fear of the unknown or have a feeling of something going wrong in the classroom when using mobile learning and hence, they will easily adopt and use mobile devices in the classroom.

Furthermore, (Callum et al., 2014) also found that lecturers' digital literacy (skills readiness) inversely correlated to their information and communication technology anxiety which, has a negative influence on their attitudes towards the use of information and communication technology in the classroom and perceived ease of use of mobile learning. Teachers who perceive their skills ready to be low often felt threatened by the use of information and communication technology for teaching (Jeffrey, Hegarty, Kelly, Penman, Coburn, & McDonald, 2011). Mutono and Dagada (2016) added that individuals who are skills ready show less anxiety when using information and communication technology as compared to those who are not skills ready. Callum et al. (2014, p. 153) concluded that anxiety will make the adoption of new technology seem harder and will ultimately result in lecturers avoiding the introduction of new technology into their teaching.

Teachers' attitudes towards mobile learning have a significant effect on their behavioural intention to use mobile learning in the classroom (Teo, 2008). If rural high school STEM teachers' attitudes are positive towards the use of mobile learning, then its implementation can easily be successful. In another study, Teo (2008) surveyed pre-service teachers' attitudes towards the use of information and communication technology use in the classroom. The researcher assessed 139 pre-service teachers for their attitudes towards the use of information and communication technology in the classroom using a questionnaire. The questionnaire had four factors: attitude towards, perceived resources, perceived control, and behavioural to use the computer. The results showed that teachers' attitudes towards the use of information and communication technology affected their behavioural intention. In a similar study, Demirci (2009) carried out a study on teachers' attitudes towards the use of geographic information systems (GIS). A total of 679 questionnaires were collected from 55 different high schools. The research showed that even though there were some barriers, such as lack of hardware and software, teachers' positive attitude towards was the major determinant of integrating GIS into lessons.

Very few studies have explored the effect of teachers' perceived enjoyment on the adoption of mobile learning. In the study by (Alshmrany & Wilkinson, 2017), one of the teachers was asked about how facilitating conditions affect his or her intention to use mobile learning in class. The teacher responded, "I have taken the initiative to use ICT in my classrooms for teaching from my personal interest" (Alshmrany & Wilkinson, 2017, p. 153). This response shows that the teachers perceive the use of information and communication technology in class as enjoyable. As a result, perceived enjoyment influences perceived attitude towards the use, behavioural intention, and actual usage of information and communication technology. In a study by Osakwe, Dlodlo, and Jere (2017), on rural teachers' perceived enjoyment, the results showed that 100% of teachers agreed that the use of mobile learning would make them enjoy their teaching. However, due to the qualitative and descriptive analysis methods used in both studies, one cannot tell whether teachers' perceived enjoyment has a significant effect on behavioural intention, perceived attitude towards, and perceived ease of use.

Teachers with constructivist beliefs believe that teaching is not about conveying knowledge but facilitating the learning process through learner-centred activities by creating active, collaborative and reflective learning environments (Kale, 2015). These constructivist beliefs are linked to perceived ease to collaborate. Teachers' constructivist beliefs affect their utilization of technology in class (Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010). The results showed constructivist beliefs positively affect perceived usefulness. Other studies also confirmed the results and stated that "teachers who embrace constructivist beliefs tend to see the benefits of mobile integration, and these beliefs lead them to utilize mobile devices for teaching to support student learning" (Hermans, Tondeur, Braak, & Valcke, 2008; Kim, Kim, Lee, Spector, & DeMeester, 2013, p. 76). This means that teachers with constructivist beliefs (perceived ease to collaborate) regard mobile devices as useful tools that can assist learners to construct their knowledge in the classroom.

In Malaysia, Yeop, Yaakob, Wong, Don, and Zain (2019) used ATAUT to investigate the factors that teachers consider important when adopting mobile learning. The researchers collected data from 720 teachers and analysed them. The factors that the study considered were behavioural intention (BI); use behaviour (UB); use expectancy (UE); perceived ease of use (PSI); facilitating conditions (FC) (PR in this study) and teacher efficacy (TE). They also integrated experience and workload as moderator variables into the study model. The results indicated teacher efficacy, perceived social influence, facilitating conditions, and use expectancy were significant factors affecting behavioural intention and use behaviour.

In another study, TAM was extended by adding system quality, facilitating conditions, and perceived self-efficacy (Fathema et al., 2015). The researchers obtained data from 560 lecturers from two universities in the USA and analysed the data using structural equation modeling. The findings revealed that the three proposed antecedents of the Technology Acceptance Model were significant predictors of lecturers' perceived attitudes towards the use of learning management systems. The results confirmed the validity of the extended Technology Acceptance Model in predicting the users' acceptance of technology. A weak positive influence of facilitating conditions on perceived ease of use and perceived attitude towards the use of technology was also revealed. This finding partially supports (Teo, 2010) who reported that facilitating conditions predicts perceived ease of use and perceived attitude towards the use of mobile learning. However, this finding does not support the findings of McGill, Klobas, and Renzi (2011), who stated that facilitating conditions did not affect learning management system utilization by instructors.

Teachers' perceived ease of use has a significant effect on their perceived attitude towards the use of M-learning (Montrieux, Grove, & Schellens, 2014). The authors used the decomposed theory of planned behaviour to study the factors that influence teachers to accept mobile learning. In the study, the researchers collected data at three different times. The results of all three waves showed that teachers' perceived ease of use influences their attitudes. What can be learned from this study is that teachers' feelings are influenced by the effort that is needed to learn to use the M-learning platform.

2.5.3 Factors that Parents of Rural High School STEM Learners Consider Important when Accepting Mobile Learning

Parental involvement in the education of their children benefits their children's learning and future success (Tsuei & Hsu, 2019). As well as acting as teachers' partners, participating parents also play a third-party role to reduce preventable disturbances when discord arises (Lueder, 1998). Parental involvement in their children's learning increases their children's Mathematics performance (Yan & Lin, 2005). Tam and Chan (2009) added that when parents are highly involved in their children's education, their children demonstrated superior academic performance.

Most rural high school STEM learners live with their parents. As a result, schools should pay attention to parents' perceptions about integrating mobile learning to extend learners' digital experience in schools to the home environment. Such integration of mobile learning requires co-operation between parents and schools (Tsuei & Hsu, 2019). Since parents of rural high school STEM learners are the overseers of activities at home, they have the utmost influence and control over what their children have access to. Their children's use of mobile learning ultimately depends on their attitudes and perceptions about it (Hiniker, Schoenebeck, & Kientz, 2016; Nikken & Haan, 2015).

A school needs support from parents for the integration of mobile learning into learners' education (Kong & Li, 2009). Integration of mobile learning benefits learners because it extends learning time and learning can take place anywhere and anytime. Kong and Li (2009) found that the easiest and most effective way of integrating mobile learning into schools is through the development of positive teacher-parent communication. Technology integration improves parents' participation in their children's learning (Kong, 2018) and benefits both teachers and children in their teaching and learning (Lewin & Luckin, 2010). However, studies have shown that parents have contradictory attitudes towards the integration of mobile learning. Rural parents recognize the usefulness of mobile devices in their children's education; however, they still have concerns about cybersecurity issues and health issues that are associated with mobile devices.

In a study carried out by Genc (2014), on the perception of parents towards mobile learning, the results showed that parents had mixed perceptions towards the use of mobile learning in the classroom. About 46.88 % of parents had negative perceptions, 26.88 % were neutral, while 26.56 % had positive perceptions towards mobile learning. Those with positive perceptions cited the benefits of mobile learning as an improvement of children's motor and cognitive skills, adaptation to technology, and improvement of visual memory, as reasons for their positive opinion. At the same time, parents with negative opinions cited the fear that their children will be introverted, have an isolated life, or might be affected by radiation from the devices. The study showed that parents consider the usefulness of mobile devices in the development of their children's motor and cognitive skills.

In another study, Kihwele and Bali (2013) found that even though rural parents are the ones who give learners mobile devices, they have negative perceptions towards the use of mobile devices in schools. The rural parents cited reasons like the improper use of phones by learners, disturbing class, and causing learners not to concentrate on their schoolwork as the causes of their negative attitude towards mobile learning. Others were also concerned by their children being able to search for uncensored content, while other learners would be busy with their phones rather than their studies. These findings are in line with Genc (2014), who found that parents have negative attitudes towards mobile learning.

Contrary to the findings by Genc (2014), parents were found to have a positive perception of mobile learning in a study by Zhu et al. (2018). Genc (2014), Kihwele and Bali (2013), and Zhu et al. (2018) also found that parents have concerns about the use of mobile learning in the classroom. However, the educational benefits of mobile learning were the key factors that parents consider when accepting mobile learning. For parents, as long as mobile learning is perceived beneficial for learning, it will be accepted despite the possible negative effects (Zhu et al., 2018).

Researchers like Genc (2014) and Kihwele and Bali (2013) found out that parents have negative perceptions towards mobile learning, while others like Zhu et al. (2018) found out that parents have positive feelings towards mobile learning. It is these inconsistencies in the body of knowledge that calls for more studies to be carried out to examine parents' perceptions. Furthermore, the scarcity of studies on parents' perceptions in the body of knowledge (Tsuei & Hsu, 2019), means more studies are needed for the successful implementation of mobile learning.

Rural high school STEM learners' parents' perceived usefulness of mobile learning predicts its acceptance and integration at home and school. In a qualitative study conducted by (Turow & Nir, 2000), the researchers found that rural parents agreed that the use of internet and information technology could contribute to children's future success. In another qualitative study conducted by (Chen et al., 2019), the researchers stated that the interviewed parents agreed that their acceptance of mobile learning is greatly affected by the benefits that mobile learning brings into the classroom, which include: a variety of educational content, interactivity for learning and the ability to learn anywhere and anytime. However, there is evidence that parents are also worried about the negative effects that mobile learning comes with. Parents are worried about healthy issues in form of a possibility of mobile learning can affect their children's eyesight; reduction of face-to-face interaction; children's reduced physical activity and hyperactivity. Additionally, parents also believed that excessive access to smartphones, iPad, and laptops would counteract the children's cognitive and social development.

Chen et al. (2019) noted that parents are concerned by their children's overdependence on search engines rather than brainstorming to solve problems. Furthermore, due to the qualitative nature of the studies, it is impossible to examine the extent to which perceived usefulness affects parents' acceptance of mobile learning.

In another study, (Zhu et al., 2018) extended the Technology Acceptance Model by adding variables; negative potential and prior experience. Perceived ease of use was renamed technical awareness, while perceived usefulness was renamed as educational benefits. The tablet acceptance questionnaire was used to collect data from 145 parents. The findings showed that parents only have positive perception towards the use of tablets when they perceive it as a useful tool to enhance their children's learning experience. Perceived usefulness had a significant effect on parents' perceived attitudes towards the use. These results are consistent with the results of the study by (Chen et al., 2019), who reported that parents' perceived attitudes is affected by their perceived usefulness. The results also revealed that negative potential and prior experiences do not predict perceived attitude towards the use of M-learning.

The study also revealed a finding that complements several prior studies (Callum et al., 2014; Sánchez-Prietoa et al., 2019; Saroia & Gao, 2018) that technical awareness (PEOU) does not have a significant effect on attitudes, but instead relied on mediating effects of perceived usefulness (educational benefits). In the same study, the researchers also investigated the same path using data collected from learners. The results also confirmed the findings that perceived ease of use does not predict attitude. The researchers stated that unless parents of rural high school STEM learners perceive the usage of the mobile device to be beneficial to learning, any level of less effort needed to learn to use the system would not affect parents' attitudes towards the use of M-learning. However, the result is contradictory to (Alshmrany & Wilkinson, 2017; Kumar et al., 2008) who found that perceived ease of use predicts perceived attitude towards the use of mobile learning.

Furthermore, (Zhu et al., 2018) concluded that rural parents' prior experience predicts educational beneficial (PU), but not the attitude towards the use of tablets. Prior experience was explained as, a behavioural attitude stimulant, as it relates to things done in the past, as it relates to knowledge of the subject matter. This explanation links prior experience to this study's skills readiness. Tablets are considered as some form of a portable computer. As a result, people's attitudes toward tablets are strongly aligned with people's attitudes toward computers (Dündar & Akçayır, 2014). The finding that prior experience (skills readiness) predicts educational beneficial (PU), complements the findings of several studies about computer skills readiness having a positive effect on perceived usefulness (Callum et al., 2014; Lefoe, Olney, Wright, & Herrington, 2009; Mueller, Wood, Willoughby, Ross, & Specht, 2008; Saadé & Kira, 2009).

Hu, Clark, and Ma (2003) also found that rural parents' prior experience had no significant effect on the behavioural intention to use tablets. This finding complements the findings of other researchers, like Zhu et al. (2018) and Kumar et al. (2008), who stressed that the overall influence of computer skills readiness on one's usage of computer deteriorates with experience on computer usage. However, the findings contradict the results of several researchers (Fathema et al., 2015; Fathema & Sutton, 2013; Park et al., 2012), who found that skills' readiness predicts behavioural intention to use M-learning. Furthermore, the attitude towards the use of tablets is negatively affected by inadequate knowledge and experience.

In another study in Taipei, Taiwan, Tsuei and Hsu (2019) extended the Technology Acceptance Model by adding the antecedents of parents' beliefs; parent-child interaction; parents' self-efficacy on information technology literacy and parent-teacher communication. Data was collected from 879 parents using a questionnaire. The structural equation modeling (SEM) was used by the researchers to examine the causal relationships and testing of hypotheses. The results were consistent with (Davis, 1989) and several other researchers who confirmed the Technology Acceptance Model's hypotheses (Davis, 1993; Donaldson, 2011; Joo et al., 2018; Mohammadi & Mahmoodi, 2019; Wang, Wang, Lin, & Tang, 2003). On the antecedents of the Technology Acceptance Model, the results showed that perceived usefulness was positively influenced by parents' beliefs and parent-teacher communication. Parent-child interaction, parents' beliefs and, parent-teacher communication predicted perceived ease of use (Taipei et al.,2019). Parent-teacher communication and parent-child interaction are part of this study of parents of rural high school STEM learners' perceived social influence.

Tsuei and Hsu (2019) found that rural parents' behavioural intention is positively affected by their attitudes towards the use of information communication technology to help children's learning at home. Those findings correspond with the findings of (Davis, 1989), who reported that behavioural intention to use m-learning is influenced by users' attitudes. The results also revealed the mediating effect of rural parents' perceived attitudes towards the relationship between perceived usefulness and behavioural intention to use information communication technology to help children's learning at home. The researchers stressed that parents of rural high school STEM learners, who perceive the use of technology to be important in their children's learning, have a positive attitude towards the use of that technology. This finding is congruent with those of previous studies (Binyamin et al., 2019; Davis, 1989; Donaldson, 2011; Mohammadi & Mahmoodi, 2019).

Parents' perceived usefulness has a positive influence on their attitude towards the use of technology for learning by their children (Mohammadi & Mahmoodi, 2019). The result is congruent with the finding of Park and Lim (2018), who stated that parents who found mobile devices to be useful for their children's education have positive feelings toward mobile learning. The parents of rural high school STEM learners who consider technology to be a useful tool for their children's learning have positive attitudes towards its use by their children at home for learning.

Rural high school learners' parents' perceived ease of use influences their perceived usefulness (Yorganci, 2017). However, the results of the relationship between perceived ease of use and perceived usefulness results are usually contradictory and might be case based. For example, the results of the studies by (Davis, 1989; Liu et al., 2018; Mohammadi & Mahmoodi, 2019) showed that perceived ease of use had a positive effect on perceived usefulness, while (Sánchez-Prietoa et al., 2019) found that perceived ease of use has no significant influence on perceived usefulness.

2.5.4 Comparing Rural High School STEM Learners', Teachers' and Parents' Attitudes Towards Mobile Learning

The integration of mobile learning in secondary education is a steadily increasing global phenomenon. Despite the extensiveness of attitudinal studies from the perspective of tertiary institutions' learners and instructors (Aburub & Alnawas, 2019; Binyamin et al., 2019; Sánchez-Prietoa et al., 2019; Saroia & Gao, 2018; Sivo et al., 2018), very few have focused on a high school context. Most of the studies that were conducted in secondary schools were conducted in urban areas. Furthermore, most of the studies that were conducted in high schools did not examine rural parents' perceptions of mobile learning (Zhu et al., 2018). Meanwhile, it is well documented that successful implementation of mobile learning is a complex process (Aburub &

Alnawas, 2019; Kumar & Chand, 2019; Robertson et al., 2006; Zhu et al., 2018), which should take into consideration the perspective of teachers, learners, and parents. Unfortunately, studies on rural parents' perceptions regarding mobile learning and a comparative analysis between rural high school STEM learners', their teachers', parents' acceptance of mobile learning have not yet been conducted (Zhu et al., 2018).

Support from the parents is the key to successful mobile learning integration (Kiger & Herro, 2015). Khan et al. (2015) stressed that parents' trust in the usefulness of mobile learning is critical to its acceptance and use in schools. This is because parents of rural high school STEM learners are the rule makers at home and are required to provide financial support. As a result, the use of mobile devices for learning at home greatly rests in their hands. Additionally, parents of rural high school STEM learners can easily influence their children's attitudes towards mobile learning (Tsuei & Hsu, 2019). Parental concerns hinder the successful implementation of mobile learning. Hence, it is important to understand these concerns and address them, to increase the chance of successful integration. The exploration of the inter-relationships between rural high school STEM learners', their parents', and teachers' attitudes towards mobile learning is necessary as it helps to expand literature. It also informs education specialists in South Africa and other developing nations and helps them to make informed decisions on the implementation of mobile learning. However, little is known about the inter-relationships between parents', learners' and teachers' attitudes towards the adoption and use of M-learning in high schools, especially in developing countries.

In developing countries, most children are more knowledgeable than their parents and teachers when it comes to technology. Children belong to a generation known by information and communication technology in education researchers as "digital native" (Prensky, 2001), "net generation" (Oblinger & Oblinger, 2005), and "new millennium learners" (Pedró, 2007). These learners have grown up in a digital environment that has shaped how they learn, play, behave, think, and do things (Gu, Zhu, & Guo, 2013). In contrast, parents and teachers belong to a generation called "digital immigrants" (Prensky, 2001a). Therefore, how technology is used in and out of classrooms and the acceptance of technology between “digital natives” and “digital immigrants” are most probably different. To successfully implement M-learning in rural high schools and at home, it is very important to understand how these two groups’ use technology in and outside the classroom. The next subsection provides what is known as the body of knowledge about the inter-difference in acceptance of mobile learning between rural high school STEM learners and their parents and teachers.

2.5.4.1 Comparing Rural High School STEM Learners’ and Parents’ Acceptance of M-learning

The Technology Acceptance Model was expanded by (Zhu et al., 2018) and a new model was used to compare the inter-relationships between parents’ and learners’ attitudes towards the acceptance of tablets in schools. The study also investigated factors that influence learners’ and parents’ attitudes on the integration of mobile learning in the classroom. The researchers used questionnaires to collect data from 212 grade seven learners and the 145 parents of these learners. The findings showed significant differences between learners’ and parents’ attitudes. The finding suggested that parents hold lesser positive views regarding mobile learning than learners. The findings confirmed the findings of prior research by Salajan, Schonwetter, and Cleghorn (2010), who suggested an inter-generational difference concerning attitudes, perceived usefulness, and perceived ease of use of mobile learning as the main reason for this difference. Similar results were also reported by (Li, Zhang, Lu, Zhang, & Wang, 2013), who cited an increase in internet addicts as the parents’ main concern. The study also revealed that both parents and learners perceive the educational benefits (perceived usefulness) as the main predictor of their attitude towards the use. Additionally, the study also revealed that learners had more a positive attitude towards the use of tablets in the classroom that their parents.

Gu et al. (2013) investigated the difference between teachers’ and learners’ acceptance of mobile learning. The questionnaire was used as an instrument to collect data from 249 teachers and 2 161 learners. Pairwise t-test and ANOVA tests were used to analyse the data. The findings showed that both teachers and learners used mobile learning more inside the classroom than outside the classroom. Female learners were found to use mobile learning more than their male counterparts. No gender differences in teachers' use of mobile learning were found. High school learners had higher in-class use of information and communication technology than middle school learners, who also, in turn, had a higher usage than primary school learners.

The findings also revealed that teachers' use of information and communication technology exceeded that of learners. This finding is in contradiction to (Li et al., 2013), who stated that children use mobile devices more than teachers. While teachers use information and communication technology more that learners, teachers' information and communication technology skills and confidence were found to be less than that of learners. This is congruent with the finding of (Prensky, 2001), who reported "digital natives" use and know how to use information and communication technology more than digital "immigrants". The study also showed that teachers' skills readiness and self-efficiency are the most powerful predictors of information and communication technology integration in the classroom. This finding confirms previous studies' findings that teachers' confidence, competence, and attitudes are the most important factors for successful information and communication technology integration (Bingimlas, 2009; Hew & Brush, 2007). Unlike teachers, the usefulness of information and communication technology was found to be the factor that learners consider more when it comes to the adoption of information and communication technology in class.

Parsons and Adhikari (2016) conducted a study in New Zealand secondary schools in the first two years of an initiative called Bring Your Own Device (BYOD). The researchers used data from a series of surveys completed by the main stakeholders in the implementation of BYOD, who were the learners, teachers, and parents. The data that was gathered from these surveys was mainly qualitative data from text questions and also included some quantitative data from structured questions. To analyse data, thematic analysis was performed by considering domains from teachers, learners, and parents. The results of the quantitative data showed that learners, teachers, and parents have positive attitudes toward mobile learning. The quantitative results also revealed that mobile learning improved teachers' and learners' digital skills and advancement in the personal growth of learners. The results also revealed that teachers had the highest number of positive attitudes towards mobile learning, which is a confirmation of the findings of (Baran, 2014; Chiu & Churchill, 2016), followed by the learners and then the parents.

Parents were mostly concerned by the nature of the media used by learners and their (media) effects on teaching and learning. However, the statistical methods used to analyse data could not reveal if there was a significant difference between teachers', learners', and parents' attitudes towards mobile learning. Additionally, the result of teachers having a higher number of positive attitudes towards mobile learning than learners contradicts several studies (Aldunate & Nussbaum, 2013; Hixon & Buckemeyer, 2009; Levin & Wadmany, 2008), which found that teachers do not make effective use of mobile learning, and have a lot of concerns about the use of mobile learning.

2.5.4.2 Comparing Rural High School STEM Learners' and Teachers' Acceptance of M-learning

In Belgium, Montrieux et al. (2014) investigated teachers' and learner's perceptions of the acceptance of mobile learning. The researchers extended the Technology Acceptance Model by adding antecedents of status and perceived enjoyment. A digital questionnaire was used to collect data on three different occasions from 83 teachers and 694 learners. Multiple regression was used to analyse the data. For teachers, the regression models of the three waves of data collection resulted in a substantial amount of variance explained in their behavioural intention of 60%, 71%, and 71% respectively. The results also showed that in the first wave, only perceived usefulness and perceived ease of use had significant effects on behavioural intention, while status and perceived enjoyment had insignificant effects. In the second wave of data, perceived usefulness, perceived enjoyment, and perceived ease of use had a positive effect on the behavioural intention to use mobile learning, while status had an insignificant effect. In the third wave, status, perceived usefulness, perceived enjoyment, and perceived ease had a significant effect on the behavioural intention to use mobile learning. For teachers, perceived usefulness had the strongest effect on the behavioural intention to use mobile learning in all three waves of collected and analysed data. Teachers recognized the tablet as an enjoyable tool to use for teaching and learning.

The model results for learners also showed a moderate variance explained in their behavioural intention to use mobile learning of 60%, 59%, and 61% respectively. However, unlike the teachers' perspective, perceived enjoyment yielded the strongest effect on learners' behavioural intention to use mobile learning in all three waves. In the first wave, all four independent variables (status, perceived usefulness, perceived enjoyment, and perceived ease) had a significant effect on behavioural intention. In the second wave, only perceived usefulness, and perceived enjoyment, persisted to have a significant effect on their behavioural intention. In the third wave, only perceived ease of use had an insignificant effect, while the other three had a significant effect on behavioural intention to use mobile learning. The learners' results indicated a mixture of both pleasure and usefulness. The researchers concluded that teacher and student models relatively mirror each other. However, the study did not show if there is a significant difference between learners' and teachers' attitudes towards mobile learning. Additionally, the results did not include parents' attitudes towards mobile learning. Furthermore, the study was carried out in Europe, which is different from the context of the current study.

Odiakaosa et al. (2017) conducted a study in rural areas of Namibia on teachers' and learners' perceptions toward mobile learning. The researchers used the Unified Theory of Acceptance and Use of Technology model to predict the acceptance of mobile learning. The data were collected using a questionnaire from 24 teachers and 120 learners. Descriptive statistics methods were used to analyse the data. The results showed that 82.4% of learners have the required skills needed for the successful implementation of mobile learning, while 100% of teachers indicated that they have the skills required for the successful implementation of mobile learning. The results also showed that 76% of learners found M-learning useful for their learning, while 93.8% of teachers found mobile devices useful for teaching. This showed that the teachers' perceived usefulness of mobile devices is higher than that of learners. On the ease of use of mobile devices, 78.6% of learners agreed that they will find using mobile learning easy, while 75% of teachers also came to the same conclusion. This finding is consistent with the finding of Kee and Samsudin (2014), who stated that young people operate mobile devices effortlessly and with motivation. The study also revealed that teachers perceive enjoyment is higher than that of learners. This was shown by 78.6 % of learners agreeing that the use of mobile devices will make their learning enjoyable, while 81.3% of the teachers expressed that they will enjoy their teaching more with mobile devices. On the perceived ease to collaborate, 77.3 % of learners agree that mobile learning will make it easier for them to work in groups, while 56.3% of teachers agreed that the use of M-learning will enhance their collaboration with other teachers. On perceived resources, the study shows that 57.3 % of learners agreed that they have the resources needed for the successful implementation of M-learning, while 50.1% of teachers agreed that they have the necessary resources for mobile learning. On behavioural intention to use mobile learning, 88% of learners stated that they intend to use mobile learning in the future, while 56.3% of teachers intend to use mobile learning in the future. However, the researchers did not include parents' perceptions, who are one of the main stakeholders for the successful implementation of mobile learning in high schools. Furthermore, the statistical methods used to analyse the data could not tell if there was a significant difference between learners' and teachers' attitudes towards mobile learning.

2.5.4.3 Comparing Rural High School STEM Teachers' and Parents' Acceptance of M-learning

Soykan (2015) conducted a study to find views of teachers, parents, and learners on the use of tablet computer usage in education. The data was collected using semi-structured interviews. The results showed that teachers had a more positive attitude than parents (Soykan, 2015). This is because parents can observe their children's behaviour at home that teachers cannot (Lewin & Luckin, 2010). In the same study, Soykan (2015) found that connectivity and technical infrastructure problems which interrupts lessons or even causing it to end as the biggest problem experienced by teachers during the learning activities. These findings were supported by Amelink and

Scales (2010), and Gunduz, Aydemir, and Isiklar (2011) who collectively concluded that technical and infrastructure problems were at the top among the problems experienced by teachers and students in transferring into mobile environments. On the other hand, the biggest concern of parents regarding the use of tablets in education was that games may decrease students' motivation (Soykan, 2015). Parents also had concerns about the health issues associated with overexposure to mobile devices. The conclusion that one can draw from the results of the study is even though teachers and parents accept the usage of tablet computers, they still have some concerns.

However, in the same study by (Soykan, 2015), teachers and parents also highlighted the benefits of using tablets computers in education. In support of tablets usage in education, teachers stated that tablet supported education adds visual elements to education and provides convenience and advantages in teaching subjects which are difficult to learn otherwise (Jones & Sinclair, 2011; Mills, 2012; Sad & Goktas, 2014). Teachers also stated that the tablet supported education to increase the learning speed of students because of visuals and interaction provided by tablets. On the other hand, parents stated that tablets computer enable their children to repeat lessons anytime, save time, ability to use the internet as a resource, provision of communication between student and teacher independent of time and space, increasing motivation, and making lessons more fun (Soykan, 2015). Based on the findings of this study one can conclude that both teachers and parents have a positive attitude towards mobile learning, but they still have some concerns. The usefulness of tablet computers in the classroom and at home causes both teachers and parents to have positive attitudes towards tablet usage in the classroom.

In a study carried out by Genc (2014) on the perception of parents towards mobile learning, the results show that about 46.88% of parents were having negative perceptions, while 26.88% were neutral and 26.56% were having positive perceptions towards mobile learning. Genc's (2014) results were congruent to Bourgonjon et al's (2011) findings, who stated that some parents expressed negative perceptions towards the use of mobile digital games-based learning. In a study conducted by Odiakaosa (2017), 87.6% of the teachers agreed that they had a positive attitude towards mobile learning, and they would like to use mobile learning to teach in the future. The other 12.5% of the teachers were neutral.

In the Free State, South Africa, another study was conducted by Venter, Wet, and Swart (2016), on the perceptions of teachers and parents of the use of a mobile application for Mathematical education. The researchers used a questionnaire to collect data from 110 grade 1-3 mathematics teachers and 450 parents. To analyse the data, the researchers used a t-test. The results showed that there was no significant difference between male and female parents' attitudes towards mobile applications. Regarding parents with and without mobile devices, the results revealed a significant difference between the two groups' perceptions of the use of mobile applications for Mathematics. Parents with mobile devices had positive attitudes towards Mathematics mobile applications, while those without devices had negative attitudes towards mobile learning.

The findings also show that 73.8 % of parents are in favour of Mathematics mobile applications, while 72.7% of the teachers had a positive attitude towards Mathematics mobile applications. However, due to the descriptive statistical methods, used to analyse data between teachers' and parents' attitudes towards mobile learning, the study could not reveal if there was a significant difference between their perceptions.

2.6 Summary of Gaps in Literature

A plethora of studies have stated that successful implementation of mobile learning is a complex process (Zhu et al., 2018; Aburub & Alnawas, 2019; Kumar & Chand, 2019; Robertson et al., 2006). To understand this complex phenomenon, several studies were conducted in tertiary institutions (Callum et al., 2014, Waheed & Jam, 2010, Aldheleai et al., 2019, Al-Emran et al., 2016, Alasmari & Zhang, 2019), that led its successful implementation. It could be argued that for mobile learning to be successfully implemented for STEM learning in rural areas, more studies are needed on the acceptance of mobile learning by rural high school STEM learners, their teachers, and parents.

Despite several learner-acceptance of mobile learning studies being conducted, most of them were conducted in tertiary institutions (Ku, 2009; Liu et al., 2018; Mutono & Dagada, 2016; Sivo et al., 2018), not in high schools. Very few studies were carried out in high school (Bourgonjon et al., 2010; Ismail et al., 2016). Bourgonjon et al. (2010) studied high school learners' acceptance of educational mobile games, while Ismail et al. (2016) focused on high school learners in urban areas. There is a need for a study specifically looking at the acceptance of mobile learning by rural high school STEM learners.

There are many studies on teacher-acceptance of M-learning that were carried out in institutions of higher learning (Callum et al., 2014; Waheed & Jam, 2010; Aldheleai et al., 2019; Al-Emran et al., 2016; Alasmari & Zhang, 2019). However, few studies have focused on schoolteachers' acceptance of M-learning (Siyam, 2019; Alshmrany & Wilkinson, 2017; Nikou & Economides, 2018). Nikou and Economides (2018) investigated the acceptance of mobile assessment in 32 European countries, Siyam (2019) focused on the acceptance of mobile learning by special education teachers and Alshmrany and Wilkinson (2017) focused on the acceptance of mobile learning by primary school teachers. Little is known about high school teachers' attitudes towards mobile learning (Yusri et al., 2014), especially in the rural areas of developing countries.

Few studies have focused on parents' perceptions towards mobile learning (Chen et al., 2019; Genc, 2014; Kihwele & Bali, 2013; Tsuei & Hsu, 2019; Turow & Nir, 2000; Zhu et al., 2018). Tsuei and Hsu (2019) investigated primary school parents' acceptance of mobile learning in Taiwan, while Genc (2014) studied pre-primary school parents' acceptance of mobile learning. Chen et al. (2019) and Turow and Nir (2000) used a qualitative approach to investigate parents' acceptance of mobile learning. The qualitative approach makes it difficult to generalize and to see if the attitudes translate to behavioural intention and eventually actual use of mobile learning. Although Kihwele and Bali (2013) investigated the acceptance of mobile learning by parents of high school learners, the study combined parents from both rural and urban areas. Additionally, Kihwele and Bali's study investigated the acceptance of mobile learning by parents of high school learners in all different subject streams. There is need for a study that investigates the acceptance of mobile learning by parents of rural high school STEM learners (Chen et al., 2019; Genc, 2014; Kihwele & Bali, 2013; Tsuei & Hsu, 2019; Turow & Nir, 2000; Zhu et al., 2018).

Additionally, there is some inconsistency in the body of knowledge on the effects of perceived ease of use, perceived usefulness, perceived resources, and perceived social influence on behavioural intention to use M-learning. Some researchers found out that these factors (perceived ease of use, perceived usefulness, perceived resources and perceived social influence) have positive effects on BI to use M-learning (Callum et al., 2014; Donaldson, 2011; Sánchez-Prietoa et al., 2019; Saroia & Gao, 2018), while other researchers have found these factors not to be predictors of behavioural intention (Huang, 2014; Pramana, 2018; Venkatesh et al., 2003). Furthermore, there is no agreement on the effects of perceived resources and perceived social influence on perceived usefulness. Ku, 2009 found these factors to be predictors of perceived usefulness, while Sivo et al. (2018) found that they do not predict perceived usefulness.

There is a need for a study to clarify these inconsistencies in the body of knowledge in a rural context. Table 2.1 shows the factors that need to be examined to clarify some inconsistencies in the body of knowledge. Some factors were never researched (based on the current knowledge of the researcher) examined in a rural high school setting for STEM learning.

Table 2.1: Emerging themes and potential factors to be examined

Theme	Challenges	Potential factors to be examined	Sources
Behavioural intention	Inconsistencies in the body of knowledge. Have not been examined in a rural context for STEM learning.	Perceived ease of use.	Hao et al. (2017); Liu et al. (2010); Pramana (2018).
Behavioural intention	Inconsistencies in the body of knowledge. Have not been examined in a rural context for STEM learning.	Perceived social influence.	Huang (2014); Venkatesh et al. (2003)
Behavioural intention	Inconsistencies in the body of knowledge. Have not been examined in a rural context for STEM learning.	Perceived resources.	Ku (2009); Sivo et al. (2018)
Behavioural intention	Have not been examined in a rural context for STEM learning.	Perceived attitude.	Montrieux et al. (2014); Zhu et al. (2018)
Behavioural intention	Have not been examined in a rural context for STEM learning.	Perceived usefulness.	Binyamin et al. (2019); Chen et al. (2019); Liu et al. (2018)
Behavioural intention	Have not been examined in a rural context for STEM learning.	perceived enjoyment.	Iqbal and Bhatti (2017).
Perceived usefulness	Inconsistencies in the body of knowledge. Have not been examined in a rural context for STEM learning.	Perceive resources.	Ku (2009).
Perceived usefulness	Inconsistencies in the body of knowledge. Have not been examined in a rural context for STEM learning.	Perceived ease of use.	Binyamin et al. (2019); Saroia and Gao (2018)
Perceived usefulness	Inconsistencies in the body of knowledge. Have not been examined in a rural context for STEM learning.	Perceived social influence.	Huang (2014); Pramana (2018)
Perceived usefulness	Inconsistencies in the body of knowledge. Have not been examined in a rural context for STEM learning.	Perceived skills readiness.	Yorganci (2017)
Perceived attitude towards the use	Have not been examined in a rural context for STEM learning.	Perceived usefulness.	Liu et al. (2018); Yorganci (2017)
Perceived attitude towards the use	Have not been examined in a rural context for STEM learning.	Perceived resource.	Ku (2009)
Perceived attitude towards the use	Inconsistencies in the body of knowledge. Have not been examined in a rural context for STEM learning.	Perceived ease of use.	Sánchez-Prietoa et al. (2019); Alshmrany and Wilkinson (2017).
Perceived ease of use.	Has not been examined in a rural context for STEM learning.	Perceived skills readiness.	Lopez and Manson (1997).
Perceived ease of use.	Has not been examined in a rural context for STEM learning.	Perceived psychological readiness.	Malhotra and Galletta (2005); Roberts and Vänskä (2011).
Perceived ease of use.	Inconsistencies in the body of knowledge. Have not been examined in a rural context for STEM learning.	Perceived resources.	Ku (2009); Sivo, Ku and Acharya (2018).
Perceived ease of use.	Inconsistencies in the body of knowledge. Have not been examined in a rural context for STEM learning.	Perceived social influence.	Fathema et al. (2015); McGill, Klobas, and Renzi (2011).

2.7 Summary

The definitions of STEM education and mobile learning were discussed in this chapter. The chapter also discussed the nature of STEM curriculum and the attributes of rural high schools in South Africa. The challenges faced with STEM education were outlined, along with ways that mobile learning can mitigate these challenges. The chapter also presented factors that rural high school STEM learners, teachers, and parents consider important when accepting mobile learning. The chapter ends by comparing rural high school STEM learners' acceptance of M-learning to their parents' and teachers' acceptance. The next chapter presents the second part of the literature review, concentrating on the theoretical framework underpinning the current study.

CHAPTER 3 THEORETICAL FRAMEWORK

3.1 Introduction

This chapter presents the theoretical framework that underpins the study. The study is aimed at assessing the determinants of rural high school STEM learners', their teachers', and parents' acceptance of mobile learning. The chapter starts by presenting four main technology acceptance theories used to examine the determinants of mobile learning. These theories are the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975); Theory of Planned Behaviour (TPB) (Ajzen & Fishbein, 1980); Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) and Technology Acceptance Model (TAM) (Davis, 1989).

As Theory of Reasoned Action, Theory of Planned Behaviour, and Unified Theory of Acceptance and Use of Technology were presented, the reasons why they could not be used in this study are also given. Additionally, the criteria used to select the Technology Acceptance Model as the theoretical framework underpinning the study is also presented.

The chapter also presents the weakness of the Technology Acceptance Model and how these were overcome in this study. Furthermore, the chapter presents the conceptual framework of the study: The South African Schools' Technology Acceptance Model (SASTAM). Lastly, the chapter ends by presenting the research hypotheses and the end of chapter conclusion.

3.2 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action was developed by Fishbein and Ajzen (1975) to predict human behaviour. It is based on social psychology and is regarded as one of the most important and powerful theories of human behaviour (Venkatesh et al., 2003). The Theory of Reasoned Action was used in many general settings to explain and predict behavioural intentions (Shepard, Harwick, & Warshaw, 1988). It posits that a person's attitude and the subjective norm predicts one's behavioural intentions, which in turn predict the behaviour (Fishbein & Ajzen, 1975). Fishbein and Ajzen (1975) found that attitudes towards behavioural intention to have a stronger influence on the acceptance of mobile learning. The attitude was defined as a person's negative or positive feelings regarding certain behaviour (Fishbein & Ajzen, 1975). The higher the degree of intention one has to do a certain behaviour, the more one is likely to do it. Subject norm was also defined as the perceived social pressure to do or not to do the behaviour in question (Fishbein & Ajzen, 1975). Figure 3.1 illustrates the Theory of Reasoned Action.

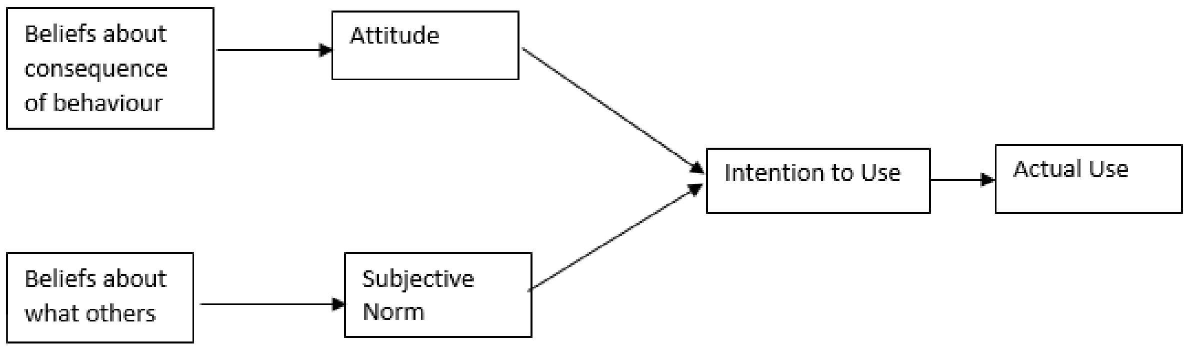


Figure 3.1: Theory of Reasoned Action model (Fishbein & Ajzen, 1975)

The Theory of Reasoned Action has been validated by various research, such as consumer and health behaviour (Greene, Hale, & Rubin, 1997; Sparks, Shepherd, & Frewer, 1995). However, researchers have also suggested that the Theory of Reasoned Action can only be applied to behaviours where an individual has volitional control (Ajzen, 1985; Hale et al., 2002; Sheppard et al., 1988). In other words, a person will only do the behaviour in question if she/he has an intention to do so. In the context of mobile learning, rural high school STEM teachers and learners might be forced to use mobile learning unwillingly, the Theory of Reasoned Action is limited to predict acceptance of mobile learning in this context.

Additionally, the Theory of Reasoned Action is limited in predicting behaviours that require access to opportunities, skills, conditions, and resources (Eagly & Chaiken, 1993). In this study, the researcher is seeking to find the determinants of mobile learning in rural areas. Mobile learning brings many opportunities to both rural STEM teachers and learners such as making STEM learning materials which is not available in rural areas to be available, visualized experiments to help STEM learners understand science concepts better since there are no science laboratories in rural areas and increase the contact time between teachers and learners (Almaiah et al., 2016; Alrajawy et al., 2017; DoE, 2017). Since the Theory of Reasoned Action is limited in predicting behaviours that require access to opportunities, it cannot be used in the current study.

The study is situated in rural areas, where most people live in poverty and rely on social grants (Mboweni, 2014). As a result, this study must investigate the effects of resources on the acceptance of mobile learning. One of the determinants of mobile learning in the current study is perceived resources, which the Theory of Reasoned Action cannot predict. Additionally, the Theory of Reasoned Action does not have a construct that assesses users' skills required to do the behaviour in question. Thus, it cannot predict behaviours that require skills; mobile learning needs rural high school STEM learners and teachers to possess technological skills for it to be successfully implemented. Due to these limitations of the Theory of Reasoned Action, which are core to the current study, this theory, therefore, does not fully meet the needs of this study.

3.3 Theory of Planned Behaviour (TPB)

In the early 1980s, Ajzen and Fishbein (1980) extended the Theory of Reasoned Action by proposing the Theory of Planned Behaviour (TPB). The Theory of Planned Behaviour adopted the assumption that an individual's attitude and subjective norm jointly influence behavioural intention, which in turn affects an individual's behaviour. However, the Theory of Reasoned Action was having a limitation that the behaviour should be under one's volitional control. In addressing this limitation, that the behaviour should be under one's volitional control, the researchers incorporated perceived behaviour control (Ajzen & Fishbein, 1980). Perceived behavioural control was incorporated as an additional factor in users' behavioural intentions and actual behaviour (Madden et al., 1992). Perceived behavioural control is defined as an individual's evaluation of the easiness of performing a particular behaviour based on control beliefs (Ajzen, 1991). Perceived behavioural control was also seen as the absence or presence of the necessary resources and opportunities needed to perform a particular behaviour (Ajzen & Madden, 1986). The control beliefs are defined as the individual's beliefs regarding the availability of factors (for example, time, money, and skills) that correspond to particular behaviours. The confidence that one has in his or her ability to do specific behaviour influences the actual behaviour (Bandura, Adams, Hardy, & Howells, 1980).

Much meta-analysis research was conducted from the Theory of Planned Behaviour based studies and it may be concluded that the constructs of the Theory of Planned Behaviour provide the explanation power to predict human behaviours (Ajzen, 1991; Armitage & Conner, 2001; Godin & Kok, 1996; Hausenblas, Carron, & Mack, 1997). However, some scholars criticized the theory, citing reasons of it ignoring individuals' needs before engaging in a certain action and needs that would affect the behaviour regardless of an expressed attitude (Sharma, 2007). It is because of this criticism that the theory cannot be used for the current study. A rural high school STEM teacher or learner might have a positive attitude towards mobile learning and yet not use it because he or she is comfortable with other learning pedagogies or his or her learning needs are met by other learning pedagogies. Additionally, rural high school STEM teachers or learners might have a negative attitude towards mobile learning but end up using it because everyone else is using it. Figure 3.2 illustrates the Theory of Planned Behaviour.

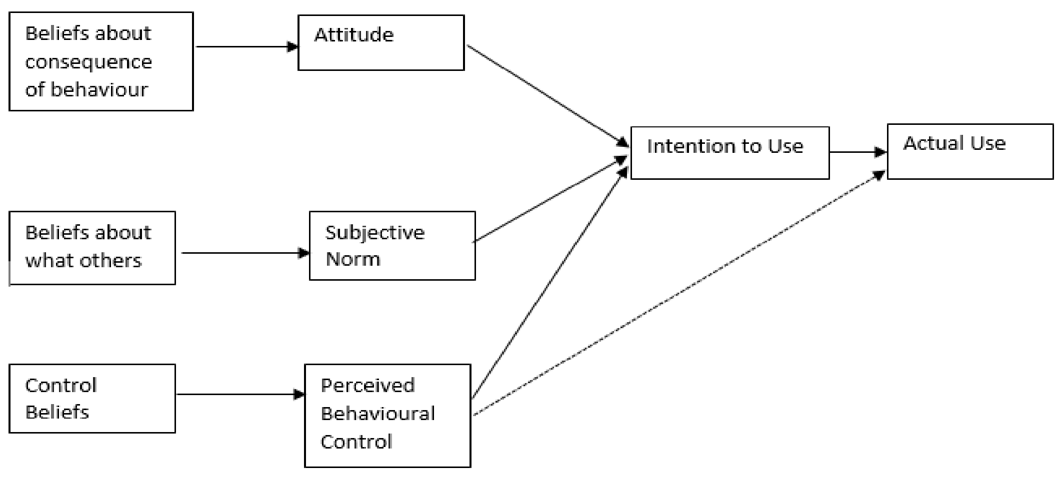


Figure 3.2: Theory of planned behaviour (Ajzen & Fishbein, 1980)

According to the Theory of Planned Behaviour, the intention to use is influenced by attitude (beliefs about the consequence of behaviour), subject norm (beliefs about what others will say) and behavioural control (availability of resources money, time and skills), all these constructs are extrinsic factors. The Theory of Planned Behaviour is limited in predicting intrinsic behaviours. Some of the factors that influence rural high school STEM learners and teachers are intrinsic like perceived enjoyment, perceived playfulness, and self-motivation. Since the Theory of Planned Behaviour can only predict extrinsic factors it cannot be used in this study.

3.4 Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology was proposed by Venkatesh et al. (2003). The researchers reviewed and empirically compared eight theories of technology acceptance and integrated elements from these models in a unified model. The underlying theories include Technology Acceptance Model (Davis, 1989), Theory of Planned Behaviour (Ajzen, 1991), TRA (Fishbein & Ajzen, 1975), the Motivational Model (MM) (Davis, Bagozzi, & Warshaw, 1992), the Innovation Diffusion Theory (IDT) (Agarwal & Prasad, 1997), the Model of PC Utilization (MPCU) (Thompson, Higgins, & Howell, 1991), the Social Cognitive Theory (SCT) (Compeau, Higgins, & Huff, 1999) and a combination of Technology Acceptance Model and Theory of Planned Behaviour (C-TAM-TPB) by Taylor and Todd (1995). Venkatesh et al. (2003) noticed that there were so many models to choose from, which caused a problem of choosing one model, thus overlooking the contributions of other models. Venkatesh et al. (2003) felt the need for a unified model that incorporates main constructs from all the eight models. However, although the Unified Theory of Acceptance and Use of Technology seems to be comprehensive since it integrates elements from eight models, it has not been used by other scholars as expected (Akour, 2009).

The Unified Theory of Acceptance and Use of Technology contains four constructs of information technology user behaviour and four moderators that were found to mediate the effect of the four constructs on the behavioural intention. The Unified Theory of Acceptance and Use of Technology theorizes that facilitating conditions, effort expectancy, performance expectancy, and social influence are direct predictors of behavioural intention or user behaviour while age, experience, the voluntariness of use, and gender are the moderators. The Unified Theory of Acceptance and Use of Technology can explain about 70% of the variance in the intention (Venkatesh et al., 2003) and as a result, it has been well accepted to predict the success of new technology. However, behavioural intention is weak in its ability to predict behaviours that are not completely within an individual's volitional control (Venkatesh et al., 2003). Mobile learning can be implemented without rural high school STEM learners' and teachers' approval and its use could be beyond their volitional control. Since the Unified Theory of Acceptance and Use of Technology cannot predict the behaviours that are beyond one's volitional control, it cannot be used in the current study.

Additionally, Mallat, Matti, Tuunainen, and Oorni (2008) stressed that the Unified Theory of Acceptance and Use of Technology does not include factors like perceived enjoyment, perceived playfulness, and self-motivation that might help explain the acceptance of mobile learning by rural high school STEM teachers and learners. Wang and Shih (2008) also added to the finding of Mallat et al. (2008) by stating that the fundamental constructs of the Unified Theory of Acceptance and Use of Technology might not reflect the unique factors that influence rural high school STEM learners, their parents and teachers to change their behavioural intention and the actual usage of mobile learning. It is because of these limitations that make UTAUT not to meet the requirements of the current study. Fig.3.3 illustrates the Unified Theory of Acceptance and Use of Technology model.

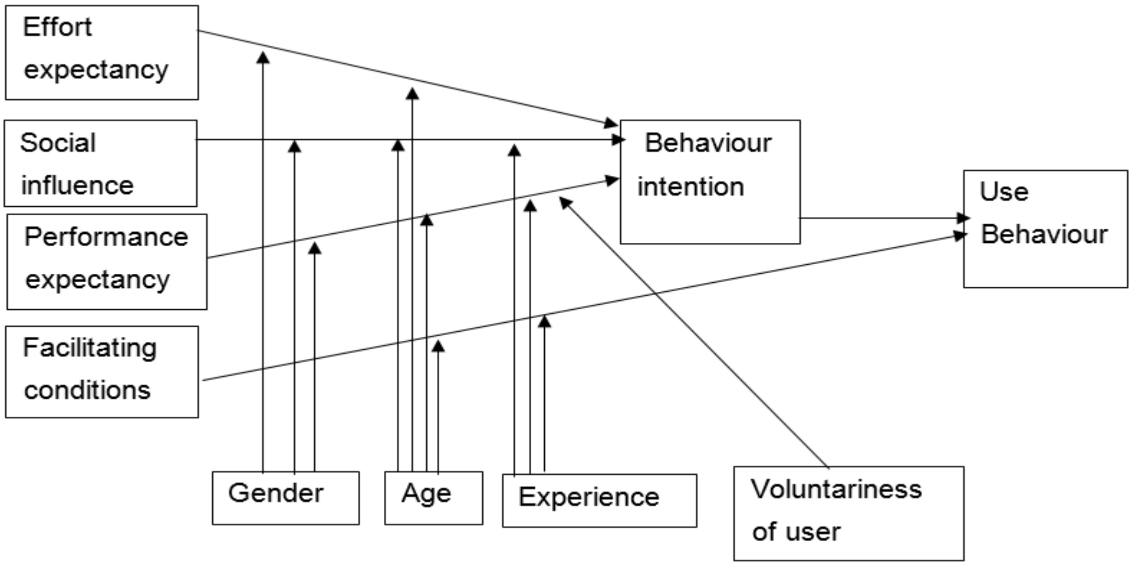


Figure 3.3: UTAUT model (Venkatesh et al., 2003)

3.5 Technology Acceptance Model (TAM)

This study used the Technology Acceptance Model to explain and predict the acceptance of mobile learning by rural high school STEM learners, their parents, and teachers in King Cetshwayo District. The Technology Acceptance Model was proposed by Davis (1989) as an improvement to the Theory of Planned Behaviour by (Ajzen & Fishbein, 1980). The Technology Acceptance Model is specifically meant to predict the acceptance and actual use of computer technology (Davis, 1989). Venkatesh (2000) stressed that the most used model to explain and predict acceptance of information systems in workplaces and academics is the Technology Acceptance Model. The model is built upon two contracts perceived usefulness and perceived ease of use.

Many researchers have considered the Technology Acceptance Model to be a robust tool across time (Morris and Venkatesh, 2000, Adams et al., 1992), technology (Doll et al., 1998), setting and population for measuring users' adoption of new technology (Adams et al., 1992; Chin, 1996; Doll, Hendrickson, & Deng, 1998; Morris & Venkatesh, 2000; Segars & Grover, 1993). Davis (1989) proposed that the use of the system can be explained or predicted by the motivation of the user.

In this study, the Technology Acceptance Model was selected because it is a well-established technology acceptance theory which was also used by other researchers to study factors that affect the acceptance of mobile learning (Adwan, Adwan, & Smedley, 2013; Huang, Lin, & Chuang, 2006; Huang, 2014; Joo et al., 2018). The Technology Acceptance Model is used to predict technology acceptance so, in this case, the Technology Acceptance Model was used to predict the acceptance of mobile learning by rural high school STEM learners, their parents, and teachers in King Cetshwayo District. The theory was also selected because it establishes a theoretical basis for explaining the causal relationship between perceived ease of use and perceived usefulness of mobile learning, and rural high school STEM learner or teacher perceived attitude towards and behavioural intention. The Technology Acceptance Model gives the researcher the ability to choose external constructs that apply to mobile learning and the rural context in which the study will be carried out. Figure 3.4 illustrates the Technology Acceptance Model.

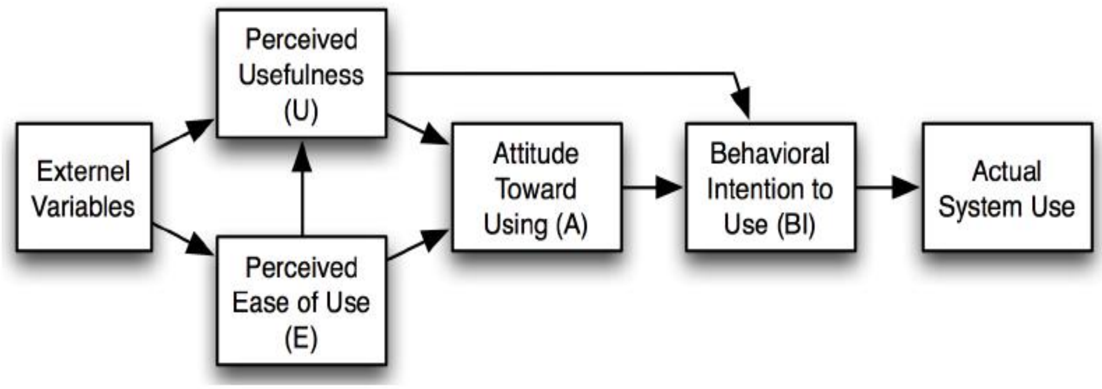


Figure 3.4: TAM Model by Davis (1989, p. 985)

The Technology Acceptance Model, like any other model, has also been criticized by other researchers (Carlsson, Carlsson, Hyvonen, Puhakainen, & Walden, 2006; Liu & Li, 2011; Mallat et al., 2008). Carlsson et al. (2006) criticized the Technology Acceptance Model for being more general and applicable to the acceptance of technology in many different fields. Carlsson et al. (2006) stressed that mobile learning is more individual, more personalized and focuses on services offered by the system. Therefore, using the Technology Acceptance Model alone in predicting the acceptance of m-learning is not enough. In dealing with this weakness the researcher will do what other researchers (Binyamin et al., 2019; Cheng, 2019; Mohammadi & Mahmoodi, 2019; Zhu et al., 2018) have done previously, coming up with antecedents of perceived usefulness and perceived ease of use that apply to mobile learning, STEM education and the rural context in which the study will be conducted in. Mallat et al. (2008) also emphasized the importance of adding new variables to the traditional adoption models, as research has shown that these newly-added variables in some cases posit stronger explanatory capabilities as compared to original variables. In responding to Mallat et al's. (2008) suggestion, the current researcher added perceived ease to collaborate; perceived enjoyment; perceived resources; perceived social influence; perceived skills readiness and perceived psychological readiness to the original Technology Acceptance Model.

Additionally, Technology Acceptance Model is also criticized for making assumptions that mostly apply in the use of technology in the workplace where all users have access to adequate resources and the use of the information system are mandatory (Mathieosn, 1991; Monsuwe, Dellaert, & Ruyter, 2004; Moon & Kim, 2001). In the educational context, the use of mobile learning is mostly voluntary. In the current study, the researcher extended the Technology Acceptance Model by adding variable perceived resources, which take into consideration that rural high school STEM teachers and learners do not have adequate resources needed for mobile learning. This variable was important considering the rural setting of the study, where many families in rural areas live in poverty and relied on social grants (Mboweni, 2014).

Furthermore, the Technology Acceptance Model is also criticized for assuming that the use of information systems is mandatory (Mathieosn, 1991). Perceived usefulness and perceived ease of use are considered to be extrinsic motivators (Monsuwe et al., 2004; Padilla-Meléndez et al., 2012). They are called extrinsic motivators because they cause the user to perform an activity for attaining valued outcomes that are different from the activity itself, for example improving rural high school STEM learner's performance. Some rural high school STEM learners may use mobile learning not because they like using the system, but because they are forced to use it to improve their performance in STEM-related subjects. The current study extended the

Technology Acceptance Model by adding perceived enjoyment which is an intrinsic motivator. Intrinsic motivators are motivators that cause the user to perform an activity for no other reason other than the process of performing it (Venkatesh, 2000). In other words, the individual is performing or engaging in an activity due to his or her interest in the activity (Moon & Kim, 2001). Rural high school STEM learners may engage in using mobile learning not because they want to improve their performance in STEM-related subjects, but for the sack of enjoying using it.

Another criticism of the Technology Acceptance Model is its low explanatory power of users' attitudes toward information systems (Sun & Zhang, 2006; Venkatesh et al., 2003). However, other researchers have found that incorporating additional external variables to the Technology Acceptance Model improves the model's explanatory power regarding users' opinions about a certain information system (Agarwal & Prasad, 1998; Lu, Yu, Liu, & Yao, 2003). Lu et al. (2003) and Agarwal and Prasad (1998) encouraged researchers to add external variables that are context related to the Technology Acceptance Model to improves explanatory power. In the current study, the explanatory power of the Technology Acceptance Model was improved by adding antecedents that apply to the acceptance of mobile learning for STEM learning in rural areas of a developing country.

3.6 Conceptual Framework

A conceptual framework model is how one theorizes the relationship between the variables that are identified as important to the problem. To find whether the theory is valid, a set of testable hypotheses were developed and tested using statistical analysis. Based on the Technology Acceptance Model a new theory South African Schools' Technology Acceptance Model was proposed.

3.6.1 South African Schools' Technology Acceptance Model (SASTAM)

The South African Schools' Technology Acceptance Model (SASTAM) is an extension of the Technology Acceptance Model. Through studying the Technology Acceptance Model, it was observed that it was necessary to add more variables from mobile learning acceptance literature while applying this model to STEM education in a rural context. Once this was been done, SASTAM was tested in rural high schools, to understand factors that explain and predict the acceptance of mobile learning for STEM learning.

As stated previously (see section 3.5), SASTAM proposed external variables of the Technology Acceptance Model's two main constructs, perceived ease of use and perceived usefulness. Based on the Technology Acceptance Model by Davis (1989), it can be assumed that rural high school STEM learners', their parents' and teachers' behavioural intention to use mobile learning is influenced by their beliefs that using mobile learning will be free of effort and the performance of learners in STEM-related subjects will improve. The external variables (perceived resources (PR), perceived social influence, perceived ease to collaborate (PEC), perceived psychological readiness (PPR), perceived enjoyment (PEN), and perceived skills readiness (PSR)) were added to the Technology Acceptance Model. These variables were assumed to have a positive influence on the original Technology Acceptance Model variables. These variables were selected based on their suitability to the context of the study.

The South African Schools' Technology Acceptance Model is an extension of the Technology Acceptance Model. The Technology Acceptance Model was proposed by Davis (1989) as an improvement to the Theory of Planned Behaviour. The Theory of Reasoned Action was also an improvement of the Theory of Reasoned Action. The South African Schools' Technology Acceptance Model borrowed some variables from the Unified Theory of Acceptance and Use of Technology and the Theory of Planned Behaviour. The variables perceived enjoyment and perceived social influence form the construct subjective norms in the Theory of Planned Behaviour. Perceived skills readiness and perceived psychological readiness form part of behavioural control in the Theory of Planned Behaviour. These four constructs from the Theory of Planned Behaviour were added to the Technology Acceptance Model to form part of the South African Schools' Technology Acceptance Model. 'Perceived resources' was borrowed from the Unified Theory of Acceptance and Use of Technology where it is known as facilitating conditions. These variables were taken from mobile learning acceptance literature and were added to the Technology Acceptance Model. The new model was then assessed to see if it can be used to explain and predict the acceptance of mobile learning in rural high schools.

The current study was conducted in a pre-implementation setting, the aim was to predict acceptance of mobile learning by rural high school STEM learners, their parents, and teachers. Therefore, actual usage from the original TAM model was not included. The behavioural intention was the variable of primary interest because it determines acceptance and usage (Davis, 1989). The behavioural intention was an exogenous variable that was directly influenced by perceived usefulness and perceived attitude towards. It was also indirectly influenced by many other external variables such as perceive resources and perceived social influence. The South African Schools' Technology Acceptance Model preserved the original Technology Acceptance Model assumptions that variables affect perceived ease of use affects perceived attitude towards and perceived usefulness. The perceived usefulness influences perceived attitude towards and behavioural intention. Perceived attitude towards has a positive effect on behavioural intention. Behavioural intention predicts acceptance and usage.

3.6.2 Behavioural Intention (BI)

Behavioural intention to use is defined as the strength of rural high school STEM learner's or teacher's intention to use M-learning. Behavioural intention predicts system acceptance and thus actual usage (Davis, 1989; Venkatesh et al., 2003). Studies have shown that teachers' or learners' behavioural intention to use mobile learning has been shown to correlate strongly with system acceptance and thus usage (Cheng, 2019). This study focused on predicting the acceptance of mobile learning by rural high school STEM learners, their parents, and teachers. Mobile learning is not currently in place, as a result, there is no actual usage of mobile learning (DoE, 2017). However, behavioural intention is considered as the best single predictor of information system (Davis, 1989; Venkatesh, 2000). Based on the assessment by Davis (1989) and Venkatesh (2000), one can argue that understanding the factors that influence rural high school STEM learners', their teachers' and parents' behavioural intention to use mobile learning, lead to understanding the factors that affect the acceptance and actual use of mobile learning.

In a study by Azjen, Brown, and Carvajal (2004, p. 1119), the results revealed that there is a likelihood that people overestimate the likelihood that they will engage in socially desirable behaviour. Azjen et al. (2004) suggested the use of 'corrective entreaty' which explains the importance of correctly assessing behavioural intention to overcoming this difficulty. In the current study 'corrective entreaty' was in the form of a cover letter that urges respondents to say what they mean. Also, the interviews were used to assess whether participants were overestimating their likelihood to use mobile learning.

Based on the studies of Venkatesh (2000) and Davis (1989) behavioural intention is assumed to be the best single predictor of actual use. Thus, in this study, factors explaining variance in behavioural intention to use mobile learning of rural high school STEM learners, their teachers and parents were assumed to predict actual use. Therefore, the current study aimed to find out the factors that explain behavioural intention to use mobile learning of rural high school learners, their parents, and teachers.

3.6.3 Perceived Attitude Towards (ATT)

Venkatesh et al. (2003) defined Perceived attitude towards in the context of technology acceptance research as a person's overall affective reaction toward the utilization of new technology. In the current study, perceived attitude towards can be defined as a rural high school STEM learner's or teacher's overall affective reaction toward the use of mobile learning. Teachers' attitudes and beliefs toward mobile learning are important factors for successful integration (Aldheleai, Baki, Tasir, & Alrahmi, 2019). Prior studies have shown that learners' (Odiakaosa et al., 2017; Joo et al., 2016), teachers' (Aldheleai et al., 2019; Siyam, 2019) and parents' (Dutota, Bhatiasevib, & Bellallahom, 2019; Tsuei & Hsu, 2019) perceived attitude towards positively influence their behavioural intension to use mobile learning.

In a mobile learning context, studies by Montrieux et al. (2014) and Anderson, Schwager, and Kerns (2006), collectively emphasized the importance of managing user's (learners' and teachers') attitudes, as it (perceived attitude towards) is the best predictor of acceptance of mobile learning. According to Venkatesh (2003), perceived attitude towards the use is influenced by perceived ease of use, perceived usefulness, and other factors that are specific to the technology in question. In this study, it is assumed that if rural high school STEM teachers, parents, and learners believe that mobile learning will improve learners' performance in STEM-related subjected and also believe that using mobile learning will be free of effort, they will have a positive perceived attitude towards the use of mobile learning. It is believed that when a learner has a positive attitude towards mobile learning, the learner's behavioural intention is very strong, and hence the learner will most likely use the system (Chen et al., 2019; Mohammadi & Mahmoodi, 2019).

Thus, in the current study, the perceived attitude towards the use was examined to answer the question: To what extent, and why, do perceived attitude towards the use explain the variances in the behavioural intention to use mobile learning by rural high school STEM learners, their parents, and teachers?

3.6.4 Perceived Usefulness (PU)

The current study defined perceived usefulness as the perception that using mobile learning improves or boosts learners' performance in STEM-related subjects. This definition was derived from the original definition by (Davis, 1989, p. 320), who defined Perceived usefulness as "…the degree to which a person believes that using a particular system would enhance his or her job performance." If perceived usefulness is strong, it creates a positive attitude towards mobile learning and as a result, increases learners' intention to use it. In the original Technology Acceptance Model by Davis (1989), behavioural intention to use a system was influenced by both perceived usefulness and perceived attitude towards its use. Many other researchers also confirmed this finding (Al-Fahad, 2009; Doll et al., 1998; Henderson & Divett, 2003; Huang, Lin, & Chuang, 2006; Wang et al., 2003). In a mobile learning context, recent studies (Aburub & Alnawas, 2019; Chen et al., 2019; Liu et al., 2018; Yorganci, 2017) have also found that perceived usefulness is the major predictor of both behavioural intention and perceived attitude towards. In some studies that used the Unified Theory of Acceptance and Use of Technology, performance expectance (PU in TAM), has proven to be the best predictor of behavioural intention (Alotaibi & Wald, 2014; Momani & Abualkishik, 2014). Alotaibi and Wald (2014) stressed that performance expectancy is a strong predictor of behavioural intention in both mandatory and voluntary settings. Thus, as demonstrated in both the Technology Acceptance Model and Unified Theory of Acceptance and Use of the Technology, the perceived usefulness is one of the best predictors of acceptance of mobile learning, because users usually look at the benefit to be gained by using mobile learning.

The Performance Expectancy (same as PU in UTAUT) is a good predictor of behavioural intention to utilize mobile learning (Bere, 2014). Rural high school STEM learners will perceive mobile learning as valuable because it will enable them to visualize science experiments, increase contact time and also have access to learning materials anywhere, anytime, all these will enable them to finish their learning objectives speedily and with flexibility. Therefore, in the current study, perceived usefulness was examined to answer the question: To what extent and why perceived usefulness explain variances in the behavioural intention to use M-learning by rural high school STEM learners, their parents, and teachers?

3.6.5 Perceived Ease of Use (PEOU)

The perceived ease of use was defined as the perception that the use of mobile learning will be free of cognitive effort. This definition is close to the definition of effort expectancy in Unified Theory of Acceptance and Use of Technology by Lowenthal (2010), who defined it as the extent to which users believe that an e-learning system is easy to use. Studies have shown that the perceived ease of use has a positive impact on perceived attitude towards the use (Davis, 1989; Doll et al., 1998; Mutono & Dagada, 2016; Padmanathan & Jogulu, 2018). Perceived ease of use is also theorized to be a predictor of perceived usefulness (Huang et al., 2006).

If users feel that the information system is easy to use, they are most likely to consider it as useful (Almasri, 2014). This finding was also confirmed by Yorganci (2017) who stated that if the information system is easy to use many users will realise the benefits of using the information system. However, some studies have found that perceived ease of use has an insignificant effect on perceived ease of use (Sánchez-Prietoa et al., 2019; Saroia & Gao, 2018). This is understandable because Davis (1989) stated that perceived ease of use is expected to be more salient when a new behaviour is in its early stages. Mobile learning is still in its early stages in South Africa especially in rural areas, it is believed that rural high school STEM learners', their teachers' and parents' perceived ease of use will indirectly have a positive influence on their behavioural intention and have a direct positive impact on their perceived usefulness and perceived attitude towards the use.

If rural high school STEM learners and teachers have to make an enormous effort to be able to use mobile learning, they will not feel satisfied; accordingly, perceived ease of use will affect their levels of satisfaction. Furthermore, rural high school STEM learners and teachers may stop the use of mobile learning if their (M-learning) developers do not offer them mobile learning platforms that are easy to use. Nevertheless, the literature on mobile learning acceptance reveals that perceived ease of use is important in finding out whether users intend to make use of mobile learning.

Accordingly, in the current investigation, perceived ease of use was examined to answer the question: To what extent and why does perceived ease of use explain variances in perceived usefulness and perceived attitude towards the use mobile learning by rural high school STEM learners, their teachers and parents?

The Technology Acceptance Model's external variables that are linked to individual differences play a significant role in the implementation of mobile learning (Wang et al., 2003). Furthermore, Agarwal and Prasad (1997) believed that the Technology Acceptance Model found strong relationships between individual differences and acceptance of a system. To understand parents', teachers' and learners' perceptions of mobile learning, South African Schools' Technology Acceptance Model integrates six individual different variables, namely perceived resources, perceived social influence, perceived ease to collaborate, perceived psychological readiness, perceived enjoyment, and perceived skills readiness. Figure 3.5 shows the South African Schools' Technology Acceptance Model.

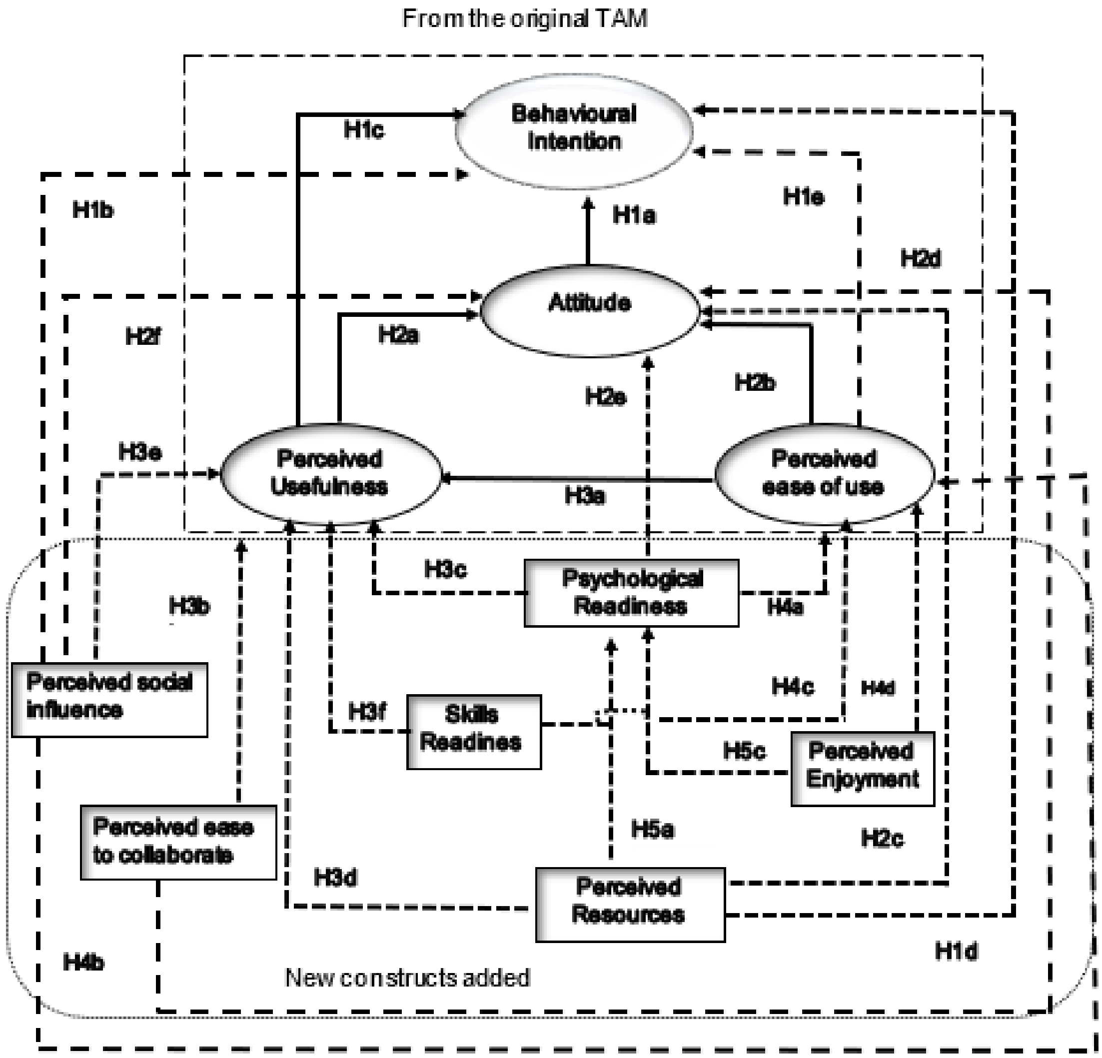


Figure 3.5: Proposed model - South African Schools' Technology Acceptance Model (SASTAM)

3.6.6 Perceive Ease to Collaborate (PEC)

In a collaborative learning environment, learners are encouraged to be interdependent and every learner is accountable for his or her own and also other learners' learning process (Dillenbourg, 1999). This is achieved by giving learners the chance to receive other learners' perspectives and enhance an individual's critical thinking skills by comparing and evaluating opposing viewpoints (Liu, 2016). Studies show that mobile learning supports collaborative learning and it enhances individual knowledge development, as well as group knowledge sharing (Bazelais & Doleck, 2018; Kadir & Ercan, 2018; Padmanathan & Jogulu, 2018).

Collaboration plays a vital role in learners' satisfaction and learning levels and also has a significant impact on effective learning. Mobile learning plays a vital role in changing human-computer interaction and learning activities (Hussin, Manap, Amir, & Krish, 2012). Mobile learning can make the interaction between learners and other learners, and also between teachers and learners, easy. Rural high STEM learners' collaboration allows them to exchange learning materials, information, thoughts, ideas, and comments from teachers.

In a study that was conducted in Namibia, they found that 77.3% of the learners agreed that mobile learning does enhance group discussions with peers (Odiakaosa et al., 2017). In rural areas studies have shown that learners' absenteeism is very high (Mboweni, 2014). In these situations, STEM learners who are absent on a particular day can collaborate with learners who were present, both learners will benefit. When rural high school STEM learners and teachers perceive that it is easy to collaborate in a mobile learning environment, they are likely to realize the utility of mobile learning.

However, little is known about the perceived ease to collaborate as a variable that rural high school STEM learners, teachers, and parents consider when accepting mobile learning. Understanding the relationship between perceived ease to collaborate and perceived usefulness helps developers of mobile learning to make systems that will enable learners to collaborate easily. Therefore, in this study, perceived ease to collaborate was examined to answer the questions: To what extent and why does perceived ease to collaborate explain variances in perceived usefulness to use mobile learning by rural high school learners, their parents, and teachers? To what extent does perceived ease to collaborate indirectly influence the BI to use M-learning by rural high school STEM learners, their teachers, and parents.

3.6.7 Perceived Psychological Readiness (PPR)

Sopu, Chisaki, and Usagawa (2016) found that high school learners were psychologically ready for mobile learning. Chaka and Govender (2017) also found that learners in colleges had positive perceptions of mobile learning. If learners have positive perceptions about mobile learning, they are most likely to have a positive perception of its usefulness and its ease of use. Malhotra and Galletta (2005) examined users' commitment (e.g. psychological attachment) to the use of a new information system. They found users' commitment to having a direct influence on perceived usefulness and perceived ease of use but having an indirect influence on perceived attitudes towards and behavioural intention (ibid). In contrast to the findings of Malhotra and Galletta (2005), a study by (Roberts & Vänskä, 2011) found that some learners had a negative attitude to the use of Mxit (free instant messaging application) and, as a result, they did not participate in the project. More studies are needed to clarify these inconsistencies in the body of knowledge.

Perceived psychological readiness can be described as the feeling that the user feels when faced with the likelihood of having to use an information system. According to Alenezi, Karim, and Veloo (2010), these feelings can range from nervousness to fear. Rural high school STEM teachers and learners who have used mobile devices for a long time have more confidence in their aptitude to use mobile devices efficiently. The competence of rural high school teachers and learners is directly influenced by their confidence to use mobile learning for teaching and learning STEM-related subjects in the classroom. Understanding rural high school STEM teachers' and learners' helps policymakers to plan for workshops to equip rural high school STEM teachers and learners with the skill needed to improve their confidence in the use of mobile learning. If rural high school STEM teachers and learners are psychologically ready, they will perceive M-learning useful and easy to use.

Consequently, in this research, perceived psychological readiness towards using M-learning was examined to answer the questions: To what extent and why does perceived psychological readiness about technology explain variances in the perceived usefulness and perceived ease of use of mobile learning by rural high school

STEM learners and teachers? To what extent does perceived psychological readiness indirectly influence BI to use M-learning by rural high school STEM learners, their teachers, and parents.

3.6.8 Perceived Resources (PR)

Perceived resources are also known as facilitating conditions in Unified Theory of Acceptance and Use Technology was defined as the degree to which an individual believes that organizational and technical infrastructure exists to support the use of the system (Venkatesh et al., 2003). In the M-learning context, school environment, internet connection, digital content, mobile devices, infrastructure, data, and equipment are considered as resources that affect the usage.

Learners with devices, financial resources, internet connection, and the required skills for using mobile learning are most likely to be psychologically ready to use mobile learning. This was supported by Erlich, Erlich-Philip, and Gal-Ezer (2005) who found that learners who were not familiar with using computers before enrolling for an online course reported more frustration and anxiety likened to those who were used to computers. If rural high school STEM learners and teachers are provided with the resources that can support mobile learning, they will be psychologically ready for it, which in turn influences the utility of mobile learning for STEM-related subjects.

The availability of mobile devices affects perceived psychological readiness, which in turn affects the perceived ease of use of mobile devices. If rural high school teachers and learners already have and already use mobile devices, they will have a positive attitude towards mobile learning and will find it easy to use these devices for learning. Learners' perceived resources positively affect behaviour intention, psychological readiness, perceived usefulness, and attitudes towards mobile learning.

However, in a study by Ku (2009), on the relationship between perceived resources and perceived usefulness, the path showed a significant coefficient beta of 0.208 ($p < .05$) in a pre-test and 0.10 7 ($p < .05$) in a post-test. Ku (2009) concluded that the research data only partially support the hypothesis that perceived resources has a positive effect on perceived usefulness. The researcher suggested more research would be needed to clarify the relationship between perceived resources and perceived usefulness (Ku, 2009). If rural high school STEM learners and teachers are provided with resources for mobile learning, they will realize the benefits that mobile learning brings into a STEM classroom such as making learning material accessible and visualization of experiments.

In the same study, the relationship between perceived resources and perceived ease of use, the path showed a significant coefficient beta in the pre-test of ($\beta = 0.347$, $p < .05$) and post-test ($\beta = 0.564$, $p < .05$) (Ku, 2009). Ku (2009) concluded that perceived resources has a positive effect on perceived ease of use. Based on the study by Ku (2009), it could be assumed that, if rural high school STEM learners and teachers are provided with the mobile learning resources needed for STEM learning, they will find it easy to learn and be proficient in using mobile learning for STEM learning.

On the relationship between perceived resources and attitude, the researcher found in both pre-tests and post-tests that attitude towards mobile learning use was not directly influenced by perceived resources (Ku, 2009). Based on the results of both pre-test and post-test of the study by Ku (2009), one can assume that if rural high school STEM teachers and learners are provided with mobile learning resources, they will be having a positive feeling about mobile learning, which in turn has a positive effect on their acceptance.

Perceived resources influence behavioural intention to use mobile learning (Zalah, 2018b). The Unified Theory of Acceptance and Use of Technology was used to investigate the acceptance of mobile learning by high school teachers and found that facilitating conditions (perceived resources) positively influence behavioural intention to use mobile learning (Zalah, 2018). Zalah (2018) stated that facilitating conditions (perceived resources) is a key predictor of behavioural intention to use mobile learning whenever there are constraints on resources. Based on Zalah's (2018) assessment, it could have assumed that due to the setting of the study (rural areas where according to Mboweni (2014) people live in poverty and rely on social grants for survival) rural high school STEM learners', their parents' and teachers' behavioural intention to use mobile learning will be influenced by their perceived resources.

In rural areas, high school STEM learners and teachers need to provide their data and their own devices for the successful implementation of mobile learning. In rural areas, affordability is a challenge as many families rely on a social grant for survival (Mboweni, 2014). Understanding how the availability or unavailability of resources influences the acceptance of mobile learning in rural areas will help policymakers to plan well for the successful implementation of mobile learning.

Accordingly, this study, perceived resources were examined to answer the questions: To what extent and why do perceived resources explain variances in perceived ease of use, perceived usefulness, perceived attitude towards and behavioural intention to use of mobile learning by rural high school STEM teachers and learners? To what extent does perceived resources indirectly influence behavioural intention to use M-learning by rural high school STEM learners, their teachers, and parents.

3.6.9 Perceived Skills Readiness (PSR)

Young people are digital natives who can operate mobile devices effortlessly and with motivation (Kee & Samsudin, 2014). This was also confirmed by the study of Odiakaosa et al. (2017) who stated that 91.1% of learners could use mobile devices and can explore these devices and their extended features. This means that most learners have the required skills for the implementation of mobile learning. Learners with required technical skills will engage better with mobile learning than those without the skills (Mutono & Dagada, 2016). Learners with required technical skills show less anxiety and frustration when taking online courses as compared to those without (ibid).

Learners who possess the required skills for mobile learning are most likely to consider mobile learning as useful and easy to use. Skills readiness can be defined as one's perception of his or her capability to use a mobile device in a mobile learning environment for the accomplishment of a learning task (Akour, 2009). Skills readiness shares a similar definition with self-efficacy, which is defined as the personal belief in one's own ability to complete tasks and reach goals (Huang, 2014).

Park and Chen (2007) reported that self-efficacy has a positive effect on perceived ease of use and behavioural intention to use smartphones, these findings confirm the result of prior studies (Compeau & Higgins, 1995; Lopez and Manson (1997); Venkatesh & Davis, 1996), who collectively found that perceived ease of use is influenced by self-efficacy. However, Lopez and Manson (1997) reported computer self-efficacy to have a significant but less substantive influence on usage directly and indirectly through perceived usefulness. It is these inconsistencies in the body of knowledge on the constructs that calls for more studies to clarify the relationship between skills readiness and perceived ease of use. Based on the studies by Park and Chen (2007), Lopez and Manson (1997), and Compeau and Higgins (1995), one can assume that rural high school STEM learners and teachers who are skills ready are most likely to find mobile learning easy to use and useful.

Therefore, in this study, perceived skills readiness was examined to answer the questions: To what extent and why perceived skills readiness explain variances in rural high school STEM teachers' and learners' perceived usefulness and perceived ease of use? To what extent does perceived skills readiness indirectly influence behavioural intention to use mobile learning by rural high school STEM learners, their teachers, and parents.

3.6.10 Perceived Enjoyment (PEN)

People engage in actions because these actions lead to pleasure (Huang et al., 2006). Perceived enjoyment was defined by Huang et al. (2006) as the degree to which the action of using the technology is perceived to be pleasurable in its own right, apart from any performance consequences that may be anticipated. In the current study, perceived enjoyment means the degree to which a rural high school learner or teacher finds the interaction of mobile learning intrinsically enjoyable or interesting. Perceived enjoyment is seen as an example of intrinsic motivation, and it has significant effects on mobile learning acceptance. Furthermore, research on the role of perceived enjoyment suggested the importance of enjoyment on users' attitudes and behaviours (Yi & Hwang, 2003). Wang, Wu, and Wang (2008) found perceived playfulness (same as perceived enjoyment in the current study) to be a significant determining factor of the behavioural intention to use mobile learning. Huang et al. (2006) also reported that perceived enjoyment to have a significant positive influence on perceived attitudes towards the use of mobile learning. Rural high school STEM learners' and teachers' acceptance and use of mobile learning can be promoted by making learning activities more enjoyable. The rationale is that learners who enjoy using mobile learning are more likely to use it extensively than those who do not (Huang, 2014).

However, all these studies were carried out in institutions of higher learning of developed countries, not in rural high schools of developing nations. Donaldson (2011) stated more studies should be carried out on perceived enjoyment as a determinant of mobile learning acceptance in remote locations or minorities who receive no or little focus in literature. Therefore, in the current study, perceived enjoyment was examined to answer the questions: To what extent and why do perceived enjoyment explain variances in rural high school STEM teachers' and learners' perceived ease of use and psychological readiness to use mobile learning? To what extent does perceived enjoyment indirectly influence rural high school STEM learners', their teachers' and parents' behavioural intention to use mobile learning

3.6.11 Perceived Social Influence (PSI)

In Theory of Reasonable Action and Theory of Planned Behaviour, perceived social influence is known as a subjective norm. Pramana (2018) defined perceived social influence as, the degree to which an individual perceives that important persons believe he or she should use a mobile learning system. In the current study, perceived social influence will be defined the same way it was defined by Pramana (2018). Prior studies have suggested that social influence is a strong predictor of behavioural intention (Morris & Venkatesh, 2000; Venkatesh, 2000; Venkatesh et al., 2003). In the mobile learning context, previous research has also shown that perceived social influence is a predictor of behavioural intention to use mobile learning (Huang, 2014;

Pramana, 2018). Based on the results of Pramana (2018) and Huang (2014), one may assume that rural high school STEM learners', their parents' and teachers' behavioural intention to use are influenced by what they hear about mobile learning by the people important to them.

When it comes to the relationship between social influence and perceived usefulness, Pramana (2018) echoed the finding of Huang (2014), that perceived usefulness is influenced by social influence. Based on these studies (Huang, 2014; Pramana, 2018) one may postulate that rural high school STEM learners', their teachers' and learners' social influence affects their perceived usefulness.

Regarding the effect of perceived social influence on perceived ease of use, prior research shows some contradiction. Pramana (2018) has found that perceived social influence predicts perceived ease of use, while Huang (2014) finds it not to have a significant effect on perceived ease of use. Due to these inconsistencies in the body of knowledge, this study seeks to clarify these inconsistencies by studying the effects of rural high school STEM learners', their parents', and teachers' social influence on their perceived ease of use.

Therefore, in the current study, perceived social influence was examined to answer the questions: To what extent and why social influence explain variances in rural high school STEM teachers' and learners' perceived ease of use, perceived usefulness, and behavioural intention to use M-learning? To what extent does perceived social influence indirectly influence behavioural intention to use M-learning by rural high school STEM learners, their teachers, and parents.

3.6.12 Hypotheses

The following SASTAM hypotheses were formulated and were used to evaluate the SASTAM model and to explain factors that rural high school STEM learners, their teachers and parents consider important when accepting mobile learning. All the hypotheses were tested using learners' data in order to find the factors that influence learners' behavioural intention to use mobile learning. To find the predictors of teachers' and parents' acceptance of mobile learning, the same hypotheses were also tested using teachers' and parents' data. The data from learners, teachers and parents was then combined and then used to evaluate the SASTAM.

H1: Rural high school STEM learners', their parents' and teachers' perceived attitude toward the use (ATT), perceived social influence (SI), perceived usefulness (PU) and perceived resources (PR) have a positive influence on their behavioural intention to use M-learning (BI).

H1a: ATT ➔BI; H1b: PSI➔BI; H1c: PU➔BI; H1d: PR➔BI; H1e; PEOU ➔BI

H2: Rural high school STEM learners', their parents' and teachers' perceived usefulness (PU), perceived ease of use (PEOU) and perceived resources (PR), perceived ease to collaborate (PEC), perceived psychological readiness (PPR), perceived social influence (PSI) have a positive influence on their perceived attitude towards the use (ATT).

H2a: PU ➔ ATT; H2b: PEOU ➔ATT; H2c: PR ➔ATT; H2d: PEC ➔ATT; H2e PPR ➔ ATT; H2f: PSI➔ATT

H3: Rural high school STEM learners', their parents' and teachers' perceived ease of use (PEOU), perceived ease to collaborate (PEC), perceived psychological readiness (PPR), perceived resources (PR), perceived social influence (PSI) and perceived skill readiness (PSR) have a positive influence on their perceived usefulness (PU).

H3a: PEOU ➔PU; H3b: PEC ➔PU; H3c: PPR ➔PU; H3d: PR ➔ PU; H3e: PSI ➔PU; H3f: PSR ➔PU

H4: Rural high school STEM learners', their parents' and teachers' perceived psychological readiness (PPR), perceived resources (PR), perceived social influence

(PSI), perceived skill readiness (PSR) and perceived enjoyment (PEN) have a positive influence on their perceived ease of use (PEOU) of M-learning.

H4a: PPR➔PEOU; H4b: PSI ➔ PEOU; H4c: PSR ➔PEOU; H4d: PEN ➔PEOU; H4e: PR ➔ PEOU

H5: Rural high school STEM learners', their parents' and teachers' perceived resources (PR), perceived social influence (PSI), perceived skills readiness (PSR), perceived social influence (PSI) and perceived enjoyment (PEN) have a positive influence on their perceived psychological readiness (PPR).

H5a: PR ➔ PPR; H5b: PSI ➔ PPR; H5c: PEN ➔PPR; H5d PSR➔PPR; H5e: PSI ➔ PR

3.7 Summary

This chapter presented four theories that are commonly used to explain users' acceptance of mobile learning. The first three theories were presented together with the reasons why they could not be used for this study, the theories are Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), Theory of Planned Behaviour (TPB) (Ajzen & Fishbein, 1980), Unified Theory of Acceptance and Use Technology (UTAUT) (Venkatesh et al., 2003). The Technology Acceptance Model was selected as the theoretical framework of this study. The reasons to support the selection of the Technology Acceptance Model as the theoretical framework for the study were also given. The weaknesses of the Technology Acceptance Model and how this study will overcome these weaknesses were also outlined.

Furthermore, the chapter presented the conceptual framework of the study; the South African Schools' Technology Acceptance Model (SASTAM). The factors that might influence rural high school STEM learners, their teachers, and parents to accept mobile learning were identified through reviewing prior studies. The chapter also outlined how the Technology Acceptance Model was extended by adding variables from the Reasoned Action, Theory of Planned Behaviour, and Unified Theory of Acceptance and Use Technology to form the South African Schools' Technology

Acceptance Model. The variables that were identified were perceived social influence, perceived ease to collaborate, perceived psychological readiness, perceived skills readiness, perceived enjoyment, and perceived resources were integrated into the research model (SASTAM). The chapter also presented the South African Schools' Technology Acceptance Model's hypotheses.

CHAPTER 4 METHODOLOGY

4.1 Introduction

The study examined the South African Schools' Technology Acceptance Model (SASTAM) on the rural high school STEM learners', their parents' and teachers' perceived ease of use, perceived attitude towards the use, perceived usefulness, perceived social influence, perceived ease to collaborate, perceived skills readiness, perceived ease to collaborate, perceived enjoyment, perceived resources, and perceived psychological readiness on their behavioural intention to use mobile learning in King Cetshwayo District. This chapter outlines the philosophical position of the researcher, research design, research approaches, sampling methods, instruments, and data collection and analysis procedures used in this research. The questionnaires were developed for the evaluation of the South African Schools' Technology Acceptance Model presented in Chapter 3.

4.2 Philosophical Position

The functions of research are to produce new knowledge and to establish new facts. The new knowledge is intended to inform academics, policymakers, planners, and government for developmental and economical purposes. A researcher is therefore directed by a set of values, practices, principles, concepts, and assumptions to produce trajectory for the scholarly environment. Consequently, the researcher should hold a basic set of opinions that guide action (Guba, 1990). Interpretivism and positivism are the two main worldviews identified in the past that can serve as the main philosophy guiding individuals embarking on research. These two worldviews serve as a guideline for the research work.

Until the end of the twentieth century, natural and social scientists mostly used the positivist philosophy in conducting and evaluating research. The social scientists abandon the positivist worldview of looking at social issues towards the beginning of the twenty-first century. This revolution led to the formation of the interpretivism philosophy. The interpretivism philosophy believes that the integrity of the social sciences would not be enhanced by relying on the positivist philosophy. The interpretivism philosophy shaped the entire research procedure in social sciences from the research questions, conceptual or theoretical frameworks, sampling, data collection, and analysis to the manner the final report is presented.

The main points of departure of the two philosophical positions, the positivism and interpretivism, has been (i) ontology (what is the nature of reality, feeling, existence, or being), (ii) epistemology (what counts as knowledge and how do people know), (iii) logic (what is acceptable as rigor and interferences in the development judgements) and (iv) axiology (what counts as fundamental values (moral choices, ethics, and normative judgments)). However, according to Johnson and Onwuegbuzie (2004), the methodological differences between positivism and interpretivism can cross each other's path to answer the research questions adequately. This gave birth to the emerging pluralistic approach to research called the pragmatism. Pragmatism allows the researcher to choose methods and procedures that best answer research questions (Creswell, 2014). In the current study, the researcher chose the pragmatic approach instead of a single worldview.

4.2.1 The Interpretive Paradigm

Interpretivism is also referred to as constructivism. Interpretivist believe that people seek understanding of the world in which they live in. People develop subjective meanings of their experiences towards certain things or objects. Interpretivism is a philosophical position that allows the researcher to view the world in the participants' views and experiences of the situation being studied Creswell (2003). These experiences are then used to construct, interpret, and gain understanding from the data collected. Using this philosophical position in the current study allows the researcher to understand factors that influence rural high school STEM learners, their teachers, and parents to accept M-learning from parents', learners', and teachers' point of view. This is opposed to the empirical view that truth is determined through cause and effect (Creswell, 2003).

4.2.2 The Positivistic Paradigm

Positivists hold a deterministic viewpoint that causes determine effects (Creswell 2013). Thus, post-positivists seek to identify the causes that affect outcomes. In such instances, the researcher should be able to determine the determinants of mobile learning acceptance by rural high school STEM learners, teachers, and parents in King Cetshwayo District. To generate new knowledge, a positivist adopts a scientific method. Positivists believe that there are theories that govern the world, and these theories need to be tested and refined to understand the world (Creswell, 2013). In the current study, the researcher follows the positivist view by extending the Technology Acceptance Model to form the South African Schools' Technology Acceptance Model to understand factors that rural high school STEM learners, their teachers, and parents consider important when accepting M-learning.

According to Creswell (2013), a mixed methodology approach allows the researcher to have a holistic view and strengthens the internal validity of the design. This study adopted the mixed method designs for this purpose. The study also followed the dominant - less dominant framework for carrying out a mixed method that was suggested by Creswell (2013). The quantitative approach is the dominant phase in the current research as the study is built upon testing the relationships between the predictors of mobile learning acceptance in rural areas. This makes this study follow a positivist point of view. The less dominant phase is the qualitative approach. This approach is going to be used to solicit clarification on the quantitative results.

4.2.3 Ontological Position

The goal of the research is to generate new knowledge. The researcher should be concerned about the existence of this knowledge. Ontology is the study of the existence of knowledge (Creswell, 2003). In other words, what constitutes a fact. Thus, the assumptions and positions what is the nature of reality, being or existence is the ontological position of the study. This position is concerned with what object should be studied, what it looks like, what units make it up, and how these units interact with one another (Creswell, 2003). Operating within the positivist paradigm, the researcher believes that absolute truth can never be found, and social phenomena and their meanings have an existence that is independent of social actors.

The researcher believes that human actions are caused by real causes that precede their behaviour. In this view, all of reality and, for that matter, acceptance of M-learning is already in a sense pre-determined, and therefore, absolute truth can be found. As a positivist, ‘determinism’ means that actions are caused by preceding circumstances and therefore, understanding such casual links is necessary for the prediction. Thus, it is imperative to understand the factors that affect the acceptance of mobile learning for STEM learning to be able to predict its acceptance in rural areas.

4.2.4 Epistemological positions

In the generation of new knowledge about the factors that influence rural high school STEM learners, their teachers, and parents to accept M-learning, a standard scientific approach is required. Epistemology is what counts as knowledge and how people know what they know (Creswell, 2013). The positions of positivists and the interpretivism differs again in as what counts as knowledge and advocate different methods of acquiring the knowledge.

The position as held by the positivists that knowledge exists and there are identifiable factors that influence rural high school STEM learners, their teachers, and parents to accept mobile learning. However, the current researcher’s point of departure is that this knowledge cannot only be measured objectively using a hypothesis or knowledge generated deductively from the South African Schools’ Technology Acceptance Model because it is not constant in all contexts (Cohen, et al., 2007). The differences that exist among rural high school STEM learners, their parents, and teachers required different strategies to gain this knowledge and not on rigid methods as advocated by natural scientists. Carey and Smith (1993) postulated that there is no particular right or wrong path to knowledge and no special method leads to intellectual progress. Therefore, the researcher combined both interview schedules and a structured questionnaire to acquire data.

The interviewing method ensures an adequate dialogue between the researcher and the participants and this collaborate and construct a meaningful result (Creswell, 2013).

4.2.5 Logical Positions

One critical part of the research is drawing a conclusion that will or may change situations. For people to make this conclusion, they should be able to understand and make meaning from arguments and insights advanced by the researcher (McGregor & Murnane, 2010). One of the tenets of scientific research is the authenticity of the result. The authenticity of results is attained through intellectual rigor. According to McGregor and Murnane (2010) rigor refers to whether the results are legitimate, believable, and valid and/or trustworthy. Most of these conclusions, that the results are legitimate, believable, and valid and/or trustworthy, are arrived at by looking at the methods used during data collection, analysis, and interpretation. Validity and reliability are the two cases identifiable with positivist in achieving intellectual rigor. However, the interpretivists believe in trustworthiness and unbiased criteria such as credibility, transferability, dependability, and confirmability (McGregor & Murnane, 2010).

The logical position of this study is in the positivist domain because the main tool for measuring the acceptance of mobile learning by rural high school STEM learners, their teachers, and parents was the questionnaire. The questions on the questionnaire were subjected to statistical tests to ascertain its validity and reliability. However, for the data collected using the interview schedule, trustworthiness and credibility need to be ascertained.

4.2.6 Axiological Positions

The study of what counts as fundamental values and the researcher’s consciousness is called the axiology. It deals with ethics, normative judgements, and moral choices. Axiology set to explain the role of the researcher and the participants in the research process (Mack, 2010). This branch of philosophy studies the judgements about the value. Therefore, it engages in the assessment of the role played by the researcher on all the research processes. Axiology tries to seek clarification positions as to predicting the world or only seeking to understand it or explaining it. Axiology concentrates on what does the researcher value in his/her study. This is important because the researcher's value affects how he/she conducts the study and what he/she values in the findings of the study.

Positivist believes that research must be undertaken in value free-way and the researcher is independent of the data and maintains objective stance (Creswell, 2013). In contrast, interpretivists are value bound, the researcher is involved in the researched phenomena and cannot be neutral and therefore is subjective (Creswell, 2013). Knowing values plays a large role in the interpretation of results. The current researcher adopted both objective and subjective values because the research is centred in a community and with attitudes, values, and beliefs. Humans are also affected by the value therefore, landed inquiry cannot be completely free. No matter what, these values affect what we see, what we choose to investigate and how the findings are interpreted (Johnson & Onwuegbuzie, 2004). Objectivism and subjectivism are taken care of in this study's design as it collected both quantitative and qualitative data.

4.2.7 Methodological Approach

A researcher is guided by the ontological, epistemological, logical, and axiological position of the research to select a particular research methodology. According to Guba and Lincoln (2005), the two main research methodologies are qualitative and quantitative. Quantitative and qualitative approaches should not be regarded as distinct categories (Creswell, 2013). As an alternative, they represent different ends on a continuum (Ibid). At the middle of this continuum is where mixed methods are found because it integrates elements of both quantitative and qualitative. A mixed-methods study is an approach to an investigation involving collecting both qualitative and quantitative data, mixing the two forms of data, and using different designs that may involve philosophical assumptions and theoretical frameworks (Creswell, 2013).

In trying to understand the factors that rural high school STEM learners, teachers and, parents consider important when accepting mobile learning, both quantitative and qualitative data were collected and analysed. Both quantitative and qualitative provided a more complete understanding of the determinants of mobile learning acceptance among rural high school STEM learners, their parents, and teachers in King Cetshwayo District than either approach alone. For this purpose, the study employs a mixed-methods approach.

4.3 Research Design

This study aims to examine the determinants of mobile learning acceptance in rural areas. According to Zalah (2018a), mixed methods research can be categorized by looking at the sequence, purpose, and type of data collected; this yields different approaches to mixed-methods research design. The design that is selected determines how the qualitative and quantitative datasets are to be integrated (Creswell, 2015).

Following trends in M-learning acceptance literature, this dissertation employed an explanatory sequential mixed methods design. This design has both quantitative and qualitative components to examine rural high school STEM learners', teachers', and parents' acceptance of mobile learning. The explanatory sequential mixed "explains and interprets quantitative results by collecting and analysing follow-up qualitative data" (Creswell, 2003, p. 211). The results of the qualitative data give depth and further explanation of the quantitative results. The 'explanatory sequential' design refers to the quantitative study (Phase One) followed by qualitative research (Phase Two) (see Fig. 4.1).

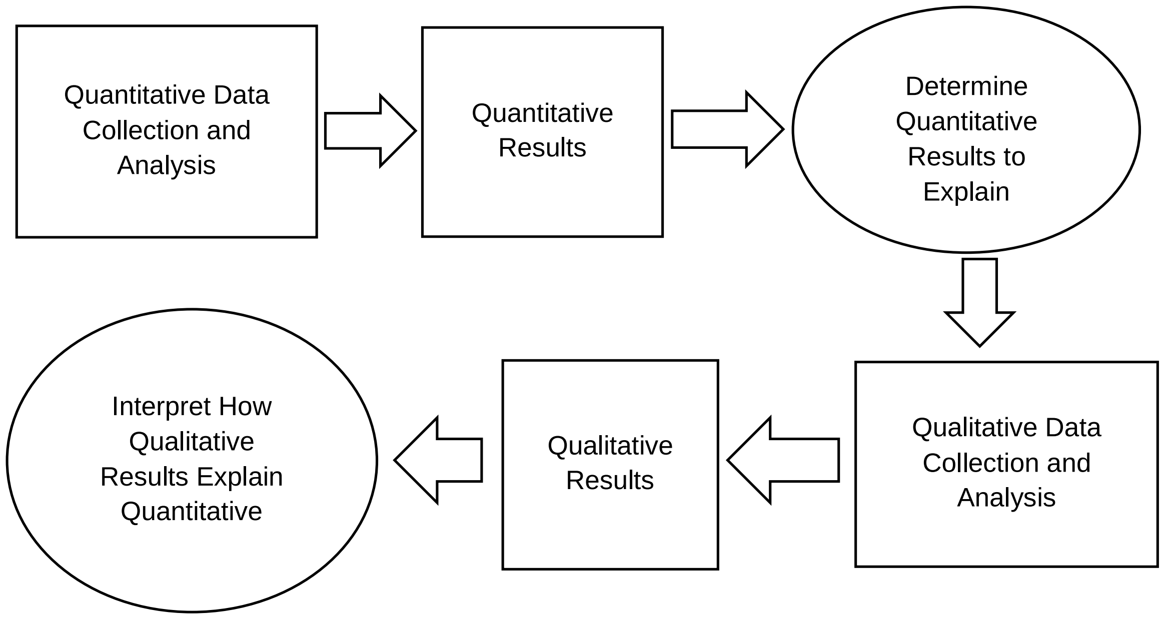


Figure 4.1: The explanatory–sequential design (Based on Creswell**, **2014, 94)

Using this design allowed the researcher to use questionnaires first, to collect quantitative data. The research used a cross-sectional survey. Cross-sectional surveys gather information at a single point in time (Creswell, 2003). Since the theoretical thrust of this study is quantitative, the survey demographics and opinion-related data resulting from the rural high school STEM learners', teachers' and parents' questionnaires were analysed first. The quantitative data analysis methods were applied to analyse survey data, discover factors that influence rural high school STEM learners', teachers', and parents' acceptance of mobile learning and relationships between the factors, and to investigate if there were difference between rural high school STEM learners' and their parents' and teachers' acceptance of mobile learning.

The data also helped to develop and validate a conceptual model (SASTAM) for mobile learning implementation in high schools. The qualitative data generated in Phase Two refined and explained why these factors which affect rural high school STEM learners', their teachers' and parents' acceptance of M-learning are significant and clarify any questions about the results.

4.4 Strengths of Mixed Methods Research

A mixed methods research has a wide range of strengths. It can combine descriptive precision with empirical precision (Onwuegbuzie, 2003). Mixed methods are armed with a bi-focal lens (that is qualitative and quantitative), as compared to a single lens; it allows a researcher "to zoom in to microscopic detail or to zoom out to indefinite scope." (Onwuegbuzie & Leech, 2005). This provides an opportunity to combine the micro and macro levels of a research issue (Onwuegbuzie & Leech, 2005). Having a bi-focal lens means that mixed methods can bring value to the investigation process itself by identifying particular shortcomings in both methods used and compensating for them (Creswell, 2003).

Anthony et al. (2005) noted that quantitative research is often inspired by the researcher's concerns. In contrast, qualitative research is typically motivated by a desire to capture the voice of the participant. The mixed-methods can merge these two emphases within a single study.

Mixed-methods enable the use of quantitative study to inform the portion of a qualitative study, and vice versa (ibid). For instance, since qualitative data cannot be generalized, the inclusion of quantitative data can help compensate for that drawback. Likewise, the relationships discovered by quantitative data can be explained by qualitative data. Additionally, merging interviews and questionnaires in one study brings together the advantages of depth and breadth accompanied by these two methods (Brierley, 2017)

Like all research approaches, mixed-methods have their limitations. The design consumes more time, for pre-planning (requires both qualitative and quantitative skills) and at the end (making the decision on how the two findings fit together and coming up with the conclusion) (Flick, 2002).

4.5 Population, Sample Size, and Participants

This study used a mixed-methods approach, using the best sample sizes for both (Phase One) quantitative and (Phase Two) qualitative phases. According to Fidel (2008) and Creswell (2013), the sample size selected needs to be justified. Nested sampling was considered suitable because the study used the explanatory-sequential design. Cohen, Manion, and Morrison (2007) stated that the nested samples involve selecting respondents for the survey, and then from the same selected respondents, volunteers are selected to be participants for the interviews.

4.5.1 Population

In this study, rural high school STEM grade 12 learners, their parents, and teachers in the King Cetshwayo District were the respondents. There are 203 high schools in King Cetshwayo District, and these high schools are ranked into five quintiles. Quintile 1 refers to schools in very poor areas and mostly rural, while quintile 5 are schools in affluent areas. Out of these 203 high schools, 168 schools are in rural areas. The schools in rural areas fall in quintile 1 to 3. The total population in this study consists of 7 912 STEM grade 12 learners and their parents and 840 teachers. Since the population is large, the academics usually cannot examine all the individuals in the total population because it would be time-consuming and expensive, sampling is therefore required.

4.5.2 Sampling and Sample Size

To understand fully the acceptance of mobile learning in the rural King Cetshwayo District, all three quintiles have to be represented in a sample, hence stratified sampling was used. Schools in the same quintile were grouped to form a stratum. Putting schools in the same quintile, in a stratum makes sure that homogenous elements are put in the same stratum, which reduces any error of estimation.

Schools in a stratum are arranged in alphabetical order and each school is assigned a number. Computer-generated random numbers were used to get four schools in each stratum. This method was used to give every rural high school in the district an equal chance of being selected, therefore, it offered an unbiased representative of the population (Rasinger, 2013). Twelve schools were randomly selected and then from these twelve schools, 20 grade 12 STEM learners were selected, using the same method used to select the school from a stratum. Five of the schools were having less than 20 STEM grade 12 learners. All grade 12 STEM learners from these schools were selected. A total of 200 STEM grade 12 learners were selected. These learners were also given one questionnaire each for their parents, making the sample size for parents to be 200 as well. A total of 150 STEM teachers were also randomly selected using the same method used to select learners. This gives each learner and teacher an equal probability of being selected and would provide a better reflection of all the rural STEM grade 12 learners and teachers in King Cetshwayo District (Padmanathan & Jogulu, 2018). The total number of participants selected were 550.

According to Bartlett, Kotrlik, and Higgins (2001) sample size tables, the sample size for teachers, learners and parents should be greater or equal to 240. Bartlett et al. (2001) compiled a table based on precision, population size and margin of error. For alpha = .05, population size of 8 000, and margin of error = .03, the sample size should be 119 or larger. The learners' population of this study was 7 912, so the sample size was 200, which is greater than 119. Perceived usefulness was the construct with most indicators. Perceived usefulness had six indicators. The sample size far exceeds the recommended 60 if we follow the recommendation that the sample size should be 10 times greater than the number of items of the construct with most items (Hair et al., 2017).

4.5.3 Participants

There is no rule of thumb when it comes to the right sample size for the qualitative phase. However, Creswell (2013) stated that researchers should work towards getting a good number that will enable them to get relevant data. In the current study, 12 participants were purposively selected from the survey respondents. The sample comprised of three teachers, three parents, and six learners.

The participants were informed that the interviews were voluntary, and they were free to withdraw during the interview. As the participants were all volunteers, as a result, the final sample size can be biased, as the participants who volunteered might be those with a lot of spare time or those who feel strongly about the topic. Nevertheless, the interviews aimed to examine the issues of mobile learning in more depth than revealed in quantitative analysis (Phase One) rather than generalizations. Group interviews were then used to interview each group (learners, teachers, and parents).

Due to the setting of the study, rural areas, all the interviews were conducted in both English and IsiZulu. And the participants were told to use any language of their choice. For STEM learners and teachers, most of the responses were in English, however the same cannot be said about parents.

4.6 Data Collection for Phase One

In this phase, the researcher gathered quantitative data that was analysed to answer the research questions of the study. Proper planning was crucial in obtaining consistent and reliable data. The data used were primary data, which were unique to the current study.

The current study used questionnaires for collecting data. Questionnaires are considered to be the most used instrument for collecting quantitative data (Creswell, 2013). Questionnaires are the most suitable instrument for collecting primary data when the number of respondents is relatively large (ibid). Therefore, questionnaires were suitable in this current research, as the previous studies did not reveal information about mobile learning acceptance by rural high school STEM learners, their teachers and parents in South Africa and the sample size for this study was 550, which was relatively large. Questionnaires also have their limitations, for example, respondents answer untruthfully, do not answer all questions, or simply misunderstand the question, and there is no researcher to explain the questions.

Even though the use of questionnaires has limitations, they were used as the instrument for collecting quantitative data in this study because they can generate the quantitative data required by this study to answer the research questions. Even though the respondents might misunderstand the questions, their responses were not going to be influenced by the presence of the researcher.

Two types of questionnaires that can be used for data collection are open-ended and closed-ended questionnaires. According to Fink (2009), open-ended questionnaire allows respondents to give answers in their own words, In contrast, in a closed-ended questionnaire, the respondents are provided with a list of answers to select from (Saunders, Lewis, & Thornhill, 2009). This study employed the closed-ended questionnaire, as minimal writing was required from the respondents (Saunders et al., 2009). It was easy for respondents and it did not take them a lot of time to respond to the questionnaire. Furthermore, on the part of the researchers, questionnaires are usually inexpensive to administer and once completed, they can be analysed easily and quickly (Birmingham & Wilkinson, 2003). Structured questionnaires that were used enabled the researcher to get quantifiable data about the respondent's opinions towards mobile learning.

To avoid inaccurate responses, the researcher gave clear simple definitions of the main terms in the questionnaire on the cover letter. Additionally, the cover letter explained the purpose of the study. The respondents were given the contact details of the researcher just in case they wanted clarifications. The questionnaires were also in two different languages, English and IsiZulu and the respondents were encouraged to respond to the questionnaire which had their language of choice. It was surprising to note that learners and teachers only collected questionnaires that were written in English. Despite the questionnaire being long, it was carefully laid down and printed on one page to make it easy for the respondents to respond to it. Respondents who participated in the pilot study indicated that although there were so many questions, it did not inhibit the respondents. This was also confirmed by a high response rate to the survey.

4.6.1 Questionnaire Design

Questionnaires were designed to collect data on the factors influencing rural high school STEM learners', their teachers', and parents' acceptance of mobile learning. The design of the questionnaire can affect data response rate, reliability and data internal validity, as such, this stage was very critical to the data collection process (Saunders et al., 2009). To design a questionnaire with questions that are understood by the respondent in the way that the researcher wanted them to, and also for the respondent's answers to be understood by the researcher in the way that the respondents wanted (Foddy, 1993), the questionnaire development had gone through many stages.

The first stage was to select questions to be included in the questionnaire. Three approaches that can be followed when designing a questionnaire are; adapting questions from previous related studies, adopting questions used in prior studies, and developing own questions (Saunders, Lewis, & Thornhill, 2012). The questionnaire for this study was modified from other researchers. Most of the questions which were used in this study were adapted and modified to suit STEM education and the rural setting of the study. Based on the assessment of Saunders et al. (2012, p 431), who stated that "adapting questions used in other questionnaires is more efficient", the researcher decided to adapt the questionnaire. Permission to adopt and modify the questionnaires was granted by the authors.

The second stage was to select an appropriate question type. Several caveats were considered in choosing the appropriate questions. For example, due to the rural setting of the study, the use of language that was too complicated was avoided, questions that encourage the respondent to respond in a particular way were also avoided and double-barrel questions (questions that ask more than one response) were also avoided. In the mobile learning acceptance research, the direct question type to measure rural high school STEM learners' their teachers' and parents' perception is Likert-scale. The current study uses a seven-point Likert-scale with strongly disagree as to the lowest scale and strongly agree as to the highest scale. The questions were typed in an agreement statement where rural high school STEM learners, their parents, and teachers selected whether they agree or disagree with the statement using seven scale points.

The third stage was the layout of the questionnaire. Dillman (2007) suggested that the general layout of the questionnaire, clear instructions and questions order are very important when designing a questionnaire. Clear instructions and definitions of key words were written to reduce errors and non-response rates. The general layout of questionnaires enabled rural high school STEM learners, their parents, and teachers to read and answer questions easily. Furthermore, Dillman (2007) stated that there is a positive relationship between a good cover page and response rate The researcher developed questionnaire cover pages that clearly explained and clarified the purpose of the study, definitions of keywords, the time needed to respond to questions on the questionnaire, the voluntary participation and the confidentiality aspects of the collected data.

The rural high school STEM learners' questionnaire (Appendix 3), teachers' questionnaire (Appendix 4) and parents' questionnaire (Appendix 5), was used to collect data on factors that influence rural high school STEM learners, their teachers and parents to accept mobile learning. The questionnaires consisted of three sections. The first section (cover letter) contained a brief description of the research, the objectives, and the importance of the study. The time needed to complete the questionnaire was also given and key concepts were also defined. Section A contained rural high school STEM learners', demographical data. It gathered data about respondents' demographic information and it only asked about gender and schooling demographics. Section B contained the questions which were adopted from previous research studies (Al-Adwan et al., 2018; Ku, 2009; Lee, 2008; Mathieson et al., 2001; Sivo et al., 2018; Rambe & Bere, 2013; Zalah, 2018) that solicited for respondents' feeling and attitudes towards learning STEM-related subjects using mobile learning. Table 4.1 presents the proposed latent variable, adapted measurement items for each latent variable and its references.

4.6.2 Questionnaire Translation

Due to the setting of the study (rural areas) and respondents (especially parents) whose home language is IsiZulu, the questionnaire was translated into IsiZulu to ensure that the respondents could understand it. Following the suggestion of Francis, Eccles, Johnston, Walker, Grimshaw, and Foy (2004), who suggested that the translation of a research instrument should be done by the native speakers of the language to which the instrument is being translated, the questionnaire was translated and verified by two IsiZulu and English teachers. To ensure the accuracy of the translated version, the IsiZulu questionnaire was translated back to English (Easterby-Smith et al., 2008). This was done to ensure that each measurement item retained its English meaning. The respondents were given a choice to select a questionnaire with a language they were comfortable with.

Participants in the pilot study were specifically asked for their responses to the language used in both the English version and the translated one (IsiZulu). The participants indicated where they thought that the words that were used were ambiguous and not appropriate for the target respondents. They also encourage the use of language that accommodates both genders. The changes were made following the feedback in both versions of the questionnaire.

4.6.3 Piloting the Questionnaire

The researcher selected one of the nearby rural high schools to take in the pilot study. All the STEM learners were given learners' questionnaires and a copy of parents' questionnaires to give to their parents at home. All the STEM teachers at the school were also given teachers' questionnaires. The cover letter and consent forms were sent together with the questionnaire. Three professors from the University of Zululand were also selected to be part of the pilot study. The professors were asked for feedback and their feedback was considered and necessary changes were done to the questionnaire. A total of 67 valid questionnaires were collected. The researcher re-evaluated the questionnaire considering the feedback, and the following changes were made:

- Mobile learning was defined in simpler terms.
- STEM education defined.
- Some of the questions were re-worded.

Table 4.1a and Table 4.1b shows the questions that were used in the questionnaire and their sources.

Table 4.1a: Measurement Scale Development

Construct	Item	Measurement item	Source
Perceived Resources	PR1	I have mobile learning resources I would need to use for learning STEM.	(Sivo et al., 2018)
	PR2	I would be able to use mobile learning for learning STEM if I wanted to	
	PR3	I have access to the resources I would need to use mobile learning for learning STEM	
	PR4	I can get help from others when I have difficulties using Mobile Learning for learning STEM	
Perceived Usefulness	PU1	Using mobile learning in class will improve my work efficiency in learning STEM	(Sivo et al., 2018)
	PU2	Using mobile learning to learn STEM will enhance the quality of my learning	
	PU3	Using mobile learning to learn STEM would increase my productivity	
	PU4	Using mobile learning would make it easier for me to learn STEM	
	PU5	I would find mobile learning useful in learning STEM.	
Perceived skills readiness	PSR1	I have the skills I would need to learn STEM using mobile learning	Newly created
	PSR2	I can use a mobile phone to download applications from the Internet	
	PSR3	I can use a mobile phone to access information/services on the internet	
Perceived social influence	PSI1	My friends think that I should use mobile learning for learning STEM	(Zalah, 2018a)
	PSI2	Learners' parents think that I should use mobile learning for learning STEM	
	PSI3	My learners think that I should use mobile learning for learning STEM	
Perceived psychological readiness	PPR1	Mobile devices (like a phone) are difficult to use	Newly created
	PPR2	Mobile devices (like a phone) frustrate me	
	PPR3	I feel insecure about my ability to use learn STEM using a mobile device (like a phone)	
	PPR4	I need someone to tell me the best way to learn STEM using a mobile device (like a phone)	

Table 4.1b: Measurement Scale Development

Construct	Item	Measurement item	Source
Perceived ease of use	PEOU1	It will be easy to learn how to use mobile learning to learn STEM	(Sivo et al., 2018)
	PEOU2	I will find it easy to use mobile learning to teach STEM.	
	PEOU3	I will find mobile learning easy to use in STEM class	
	PEOU4	I would find mobile learning to be flexible to interact with.	
	PEOU5	It will be easy for me to become skilful in learning STEM using mobile learning	
Perceived attitude towards	ATT1	I believe it is beneficial to use mobile learning to learn STEM	(Sivo et al., 2018)); (Rambe & Bere, 2013)
	ATT2	My experience with mobile learning to learn STEM will be good	
	ATT3	I feel positive about using mobile learning for learning STEM	
	ATT4	The mobile learning application will improve my online learning experience	
	ATT5	I would like to use many different mobile applications for learning STEM in the future	
Perceived behavioural intention	BI1	Assuming I have access to mobile learning, I intend to use it to learn STEM	(Sivo et al., 2018)
	BI2	I will frequently learn STEM using mobile learning in the future.	
	BI3	I am planning to use mobile learning in learning STEM	
Perceived ease to collaborate	PEC1	Learning to collaborate using mobile learning would be easy for me	Newly created
	PEC2	I would find it easy to learn with others using mobile learning	
	PEC3	I would find it easy to work in groups using mobile learning	
Perceived enjoyment	PEN1	learning STEM using mobile learning would be enjoyable	(Al-Adwan et al., 2018)
	PEN2	I would find it fun to learn STEM using mobile learning	
	PEN3	I would find using mobile learning interesting	

4.6.3.1 Reliability of the Questionnaire

The composite reliability was used to test for the internal consistency reliability using the SmartPSL3 software (Hair et al, 2014). According to Hair et al. (2014), the composite reliability (CR) measures internal consistency reliability more accurately than the Cronbach's alpha test. Table 4.3 shows that all the CR values were greater than 0.70, confirming item reliability.

4.6.3.2 Convergent Validity of the Pilot Study

Convergent validity is the extent to which a measure correlates positively with alternative measures of the same construct (Hair et al., 2014). The outer loadings and average variance extracted (AVE) were used to evaluate the convergent validity. As shown in Table 4.3, all the outer loadings were greater than the cut-off value of 0.70, indicating convergent validity of the items. The AVE value ranged from 0.5821 to 0.8136. All the AVE values were greater than the threshold value of 0.50, meaning that the constructs explained more than half of the variance of their items.

4.6.3.3 Discriminant Validity of the Pilot Study

It is defined as the extent "to which a construct is truly distinct from other constructs by empirical standards" (Hair et al., 2014, p104). To evaluate discriminant validity, the Heterotrait-monotrait ratio of correlations (HTMT) was used (Garson, 2016). Table 4.2 shows all the HTMT values were under 0.9 (Garson, 2016). The results confirmed discriminant validity.

Table 4.2: HTMT values of the pilot study

	ATT	BI	PEC	PEOU	PR	PSI	PU	PSR	PEN	PPR
ATT										
BI	0.7711									
PEC	0.5432	0.6296								
PEOU	0.6384	0.5493	0.4160							
PR	0.5512	0.5585	0.5069	0.8604						
PSI	0.7675	0.7101	0.8525	0.5229	0.5719					
PU	0.6122	0.7930	0.8764	0.4833	0.5605	0.8713				
PSR	0.4254	0.6452	0.7412	0.5742	0.5741	0.2310	0.2014			
PEN	0.2871	0.5647	0.2155	0.8452	0.2542	0.6514	0.7241	0.8241		
PPR	0.5214	0.2555	0.1458	0.6741	0.5695	0.5741	0.6124	0.2414	0.0124	

Table 4.3: Loading, CR and AVE

Construct	Item	Loading	CR	AVE
Perceived attitude towards the use	ATT1	0.8829	0.8979	0.7456
	ATT2	0.8459		
	ATT3	0.8612		
	ATT4	0.8741		
	ATT5	0.9101		
Behavioural intention to use	BI1	0.8617	0.9256	0.7569
	BI2	0.9048		
	BI3	0.8468		
Perceived ease to collaborate	PEC1	0.9018	0.8972	0.8136
	PEC2	0.9022		
	PEC3	0.8942		
Perceived ease of use	PEOU1	0.8112	0.9062	0.7632
	PEOU2	0.8859		
	PEOU3	0.8304		
	PEOU4	0.8503		
	PEOU5	0.7855		
Perceived resources	PR1	0.8894	0.9062	0.7632
	PR2	0.8502		
	PR3	0.8807		
	PR4	0.8471		
Perceived social influence	PSI1	0.8150	0.8378	0.6338
	PSI2	0.8490		
	PSI3	0.7185		
Perceived usefulness	PU1	0.7676	0.8958	0.6323
	PU2	0.8051		
	PU3	0.7932		
	PU4	0.8122		
	PU5	0.7971		
Perceived skills readiness	PSR1	0.7101	0.7254	0.6214
	PSR2	0.8145		
	PSR3	0.8785		
Perceived enjoyment	PEN1	0.7874	0.8045	0.7142
	PEN2	0.9452		
	PEN3	0.8872		
Perceived psychological readiness	PPR1	0.8961	0.8912	0.5821
	PPR2	0.7845		
	PPR3	0.8897		
	PPR4	0.8941		

4.6.4 Data Collection Procedure

This subsection provides information on how the researcher administered the survey. According to Saunders et al. (2012) after the questionnaire has been pilot tested, necessary changes made to the questionnaire, and the study sample has been selected, the next step is to gain access to the sample.

Two weeks before the commencement of the data collection, the researcher visited all the twelve schools to ask for authorization to conduct research at their schools. The approval letter from the Provincial Head of the Department of Education was given to principals and who then gave verbal approval. The approval letter from the Provincial Head of the Department of Education was obtained before the commencement of data collection. The researcher was introduced to the head of the science department in each school by the principal. In one of the schools, the head of the science department was sick as a result, the researcher was introduced to the subject head for Physical Sciences at the school. The heads of the science department enable the researcher to get access to the respondents (STEM learners, their teachers, and parents). Most heads of the science were interested in the results of the study as they perceived the study will help them to assess the feasibility of using mobile learning. The positive attitude of most heads of the science made data collection easy for the researcher. The researcher was given dates by the heads of the science department for administering the survey to the respondents and the day for collections of the completed questionnaires. The heads of the science department collected the questionnaires on behalf of the researcher and gave them to the researcher on the date agreed upon.

The following ethical procedures were ensured by the researcher:

- Informed consent letter accompanied each questionnaire (see Annexure A):
- Parents' consent letter for all learners (see Annexure D)
- Respondents were informed of the purpose of the study.
- Respondents were informed that participation in the study was voluntary and they can withdraw at any time.
- Respondents were informed to remain anonymous.

The researcher encountered some challenges during the entire data collection exercise. Some heads of science departments were not co-operative. For example at one of the schools the researcher went to the school to collect the questionnaires after reminding the head of science about the date when the researcher arrived at the school, that is when the head of the department started looking for the questionnaires from learners, unfortunately, most of them had left them at home. The researcher had to go to the same school at a later date.

4.7 Data Analysis for Phase One

4.7.1 Structural Equation Modeling (SEM)

Structural equation modeling is a group of statistical models that are used to test theoretical models involving proposed causal associations among a set of variables (Schumacker & Lomax, 2016). According to Schumacker and Lomax (2016, p. 2), SEM “uses various types of models to depict relationships among observed variables, with the same basic goal of providing a quantitative test of a theoretical model hypothesized by the researcher.” The Structural Equation Modeling is also defined as, “a multivariate technique combining aspects of factor analysis and multiple regression that enables the researcher to simultaneously examine a series of interrelated dependent relationships among the measured variables and latent constructs (variates) as well as between several latent constructs” (Hair, Black, Babin, & Anderson, 2014).

The Structural Equation Modeling offers better advantages when applied correctly over the first generation of analysis techniques (factor analysis or multiple regression) because it allows the researcher to the interplay between data and theory (Chin, 1998). The Structural Equation Modeling allows the researcher to 1) model errors in measurement for observed variables; 2) latent variable; 3) model relationships among multiple independent variables and dependent variables; and 4) statistically test a priori theory and measure assumptions against empirical data.

According to Hair, Black, et al. (2014) there are two main approaches to estimate the relationships in a structural equation model: component-based or variance-based approaches such as partial least square (PLS-SEM) and a co-variance-based approach (CB-SEM). The underlying statistical assumptions of the two approaches are different (Gefen, Straub, & Boudreau, 2000). The two approaches also differ in terms of the nature of fit statistics they produce (Gefen et al., 2000; Hair, Black, et al., 2014). Each method suits a different study viewpoint, and investigators need to grasp the differences to apply the correct method (Hair et al., 2017). PLS-SEM is utilized to develop theory in exploratory research while CB-SEM is mainly used to confirm (or reject) theories (Hair et al., 2017). The advantages of CB-SEM are the disadvantages of PLS-SEM, and vice versa, thus the two methods are considered different but complementary statistical methods for SEM (Hair, Black, et al., 2014).

To minimize the difference between the sample covariance and those predicted by the theoretical model, the CB-SEM uses the maximum likelihood function (Hair et al., 2017). The estimated parameters attempt to reproduce the observed values' covariance matrix (Hair et al., 2017). The maximum likelihood function requires data to be normally distributed and the observations should be independent of one another (Chin, 1998; Hair, Sarstedt, Pieper, & Ringle, 2012). In contrast, PLS-SEM maximizes the covariance between the independent unobservable variable and the dependent unobservable variable (Sosik, Kahai, & Piovoso, 2009). According to Chin (1998), PLS uses the least square estimation for single and multi-component models and canonical correlation.

4.7.2 Rules of Thumb for Selecting CB-SEM or PLS-SEM

The researcher needs to understand the assumptions underlying the CB-SEM and PLS-SEM to determine which statistical method is appropriate to use (Hair et al., 2012). The selection between these two SEM statistical methods can be made based on research objective, data characteristics, type of measurement model specification, modeling of the structural model and model evaluation (Hair et al., 2012; Hair, Hult, Ringle, & Sarstedt, 2014). These five rules can be used to guide the researcher to select between PLS-SEM and CB-SEM (Hair et al., 2014).

Firstly, the objective of the research should guide the researcher when selecting between PLS-SEM and CB-SEM (Hair et al., 2014). PLS-SEM is the appropriate method to use in situations where the theory is less developed and the objective focuses on prediction and explaining the variance of key target constructs (Hair et al., 2012). PLS-SEM uses available data to “estimate the path relationships in the model to minimize the error terms of the endogenous constructs” (Hair et al., 2012, p 14). The path model relationships in PLS-SEM maximize the R-squared values of the (target) dependent variables. Thus, PLS-SEM is the preferred SEM method when the objective of the research focuses on theory development and explanation of variance. In contrast, CB-SEM is a preferred method when the research objective is to test or confirm a theory. This is based on the suggestion of Barclay, Higgins, and Thompson (1995), who stated that the ability to show how well a theoretical model fits the observed data is very important when testing theory.

Second, according to Chin (1998), PLS-SEM can be used to analyse a research model that is made up of both formative and reflective constructs. PLS-SEM gives the researcher the flexibility of use either formative, the combination of formative and reflective or reflective constructs in the same model (Hair et al., 2017). Additionally, PLS-SEM can easily handle single-item constructs, with no identification problems. Unlike CB-SEM, the PLS-SEM can handle with ease complicated models with many constructs and many observable variables (Hair et al., 2017). In contrast, in CB-SEM, the researchers are restricted to reflective constructs only (Hair et al., 2017). Henseler, Christian, and Sinkovics (2009) stated that the use of formative constructs with CB-SEM leads to identification problems.

Third, PLS-SEM uses calibration mechanisms, which changes any data which is not normally distributed into data that follows the central limit theorem, as a result, data normality is not a demand (Beebe, & Seasholtz, 1998). In contrast, CB-SEM requires a set of assumptions to be fulfilled before further analysis can be done (Beebe et al., 1998; Hair et al., 2012). The CB-SEM assumptions that need be met: 1) data multivariate normality, 2) observation independence and 3) variable metric uniformity

(Hair et al., 2014; Sosik et al., 2009). Unlike CB-SEM, PLS-SEM can also be used in situations where the sample size is relatively small, such as 10 times the number of items of the construct with the most items in the model.

Table 4.4 gives a summary of the rules of thumb in choosing between CB-SEM and PLS-SEM. Consequently, based on the aforementioned rules of thumb, in the current study, the PLS-SEM was used as an analytical technique in this study. Table 4.4 summarizes the rules of the thumb between selecting CB-SEM and PLS-SEM.

Table 4.4: Rules of thumb for choosing between CB-SEM and PLS-SEM

Criteria to evaluate		CB-SEM	PLS-SEM	Current study
1	**Research goal**			
	i. Predicting key target constructs		√	√
	ii. Theory testing, theory confirmation or comparison of alternative theories	√		
	iii. Exploratory of an extension of an existing structural theory		√	√
2	**Measurement model specification**			
	i. If formative constructs are part of the structural model		√	
	ii. If error terms require additional specification such as co-variation	√		
3	**Structural model**			
	i. If a structural model is complex		√	√
	ii. If a structural model is non-recursive	√		
4	**Data characteristics and algorithm**			
	i. Data meet distributional assumptions	√	√	√
	ii. Data did not meet distributional assumptions		√	√
	iii. Small sample size consideration		√	√
	iv. Large sample size consideration	√	√	
	v. Non-normal distribution		√	√
	vi. Normal distribution	√	√	
5	**Model evaluation**			
	i. Use latent variable scores in subsequent analyses		√	√
	ii. Requires global goodness of fit criterion	√		
	iii. Need to test for measurement model invariance	√		

Adapted from Henseler et al. (2009) and Hair et al. (2011)

4.7.3 Justification for Using PLS-SEM

The PLS-SEM is the appropriate method to use in situations where the theory is less developed, the aim focuses on prediction and explaining the variance of the main endogenous variable (Hair et al., 2012). PLS-SEM was appropriate for the current study as it sought to extend TAM by developing and evaluating a new model (SASTAM) that can be used to predict the behavioural intention to use mobile learning by rural high school STEM learners, their teachers, and parents.

The PLS-SEM works efficiently with small sample sizes such as 10 times bigger than the number of indicators of the construct with most indicators, complex models and it needs no assumptions about data distributions (Henseler, 2010). The sample size of each group of the current study is 129 parents, 174 learners and 114 teachers which are all less than 200 the minimum sample size required for the CB-SEM (Lacobucci, 2010). Additionally, the proposed model SASTAM has 10 latent variables and 27 hypotheses, which makes it complex. PLS-SEM was used in this case as it deals with complex models better than CB-SEM. Furthermore, the data used in this study were not normally distributed and as a result, PLS-SEM was preferred to CB-SEM.

The focus of the current study was to test the relationships among the constructs based on prior theoretical knowledge. The ability of PLS-SEM to estimate the correlations between the residuals and assess their impacts on the model makes this technique an appropriate approach (Hair et al., 2017). The PLS-SEM is very efficient at estimating parameters, which results in high levels of statistical power (Garson, 2016). Greater statistical power means that PLS-SEM will probably generate a specific and significant relationship when in fact it's significant in the population (Hair et al., 2014).

Several software packages have been developed for the PLS-SEM, these software packages include but not limited to PLS-Graph (Chin and Frye, 2003), LVPLS (Lohmoller, 1988), VisualPLS (FU, 2006), PLS-GUI (LI, 2005), and SmartPLS 3 (Hair et al., 2014). The SmartPLS 3 software was used to execute all the PLS-SEM analyses in the current study.

4.7.4 Evaluating Measurement and Structural Models Using Partial Least Square

The two-step process suggested by Hair et al. (2014) was used in this study to assess the research model. First, the measurement (outer) model was assessed to ascertain the validity and reliability (Urbach & Ahlemann, 2010). The second step involved the assessment of the structural model (inner) model. This was done to determine whether the model fulfils the quality criteria for empirical work (Urbach & Ahlemann, 2010). The next subsections discuss the guidelines used in this study to assess both the inner model and outer model.

4.7.4.1 Measurement Model

According to Hair et al. (2017), the validation of a reflective measurement model can be achieved by testing its convergent validity, internal consistency, indicator reliability, and discriminant validity.

4.7.4.1.1 Assessing the Internal Consistency

Traditionally, Cronbach's alpha (CA) is used to assess the outer item's internal consistency (Hair et al., 2014). The Cronbach's alpha provides an estimate of the reliability based on the intercorrelations of the observed item variables (Hair et al., 2017). Cronbach's alpha assumes that all the items are equally reliable (Hair et al., 2014). Cronbach's alpha has some weaknesses whereby it is sensitive to the number of indicators in the scale and it underestimates the internal consistency reliability. Due to the weaknesses of the Cronbach's alpha, the composite reliability (CR) is a preferred alternative to Cronbach's alpha (Hair et al., 2014). Compared to Cronbach's alpha, composite reliability may lead to higher estimates of true reliability (Garson, 2016).

Like Cronbach's alpha, the composite reliability ranges from 0 to 1. Higher composite reliability values indicate higher levels of reliability. The composite reliability is interpreted the same way as Cronbach's alpha test. The acceptable cut off of 0.7 is regarded as satisfactory (Nunally & Bernstein, 1994). However, composite reliability values of 0.6 to 0.7 are acceptable in exploratory research (Chin, 1998; Hair et al., 2014).

4.7.4.1.2 Assessing the Indicator Reliability

To evaluate the extent to which a variable or a set of variables is consistent with what it intends to measure, indicators' reliability is used (Urbach & Ahlemann, 2010). The reliability construct is independent of and calculated separately from other constructs. According to Chin (1998), the item loadings should be greater than 0.7 and indicator loadings should be significant at least at the 0.05 level. This is because constructs should explain at least 50% of the variance of their respective items (Chin, 1998; Hensler et al., 2009), and it is also the level at which the explained variance is greater than error variance (Garson, 2016). The significance of the item loadings can be verified using a resampling method, such as bootstrapping or jack-knifing (Hair et al., 2014). Indicators whose loadings are lower than 0.7 are normally removed. However, according to Hensler et al. (2009), a researcher should be cautious when deciding to delete an item, taking into consideration PLS characteristics of consistency at large.

4.7.4.1.3 Assessing the Convergent Validity

Convergent validity is "the extent to which a measure correlates positively with alternative measures of the same construct" (Hair et al., 2014, p 102). The average variance extracted (AVE) and outer loadings of the indicators are used to assess the convergent validity (Hair et al., 2014). According to Fornell and Larcker (1981), AVE value of at least 0.5 and a factor loading of at least 0.7 indicate a sufficient convergent validity. Indicators with outer loadings below 0.4 should be removed from the model (Hair et al., 2011). Items with outer loadings between 0.4 and 0.7 are candidates for removal from the model. However, they should be removed only if their removal increases the composite reliability to be above 0.7 or the AVE to be above 0.5 (Hair et al., 2017). Indicators with loadings less than 0.7 may also be retained due to their contribution to content validity. Figure 5.2 shows the recommendations regarding indicator deletion based on outer loadings.

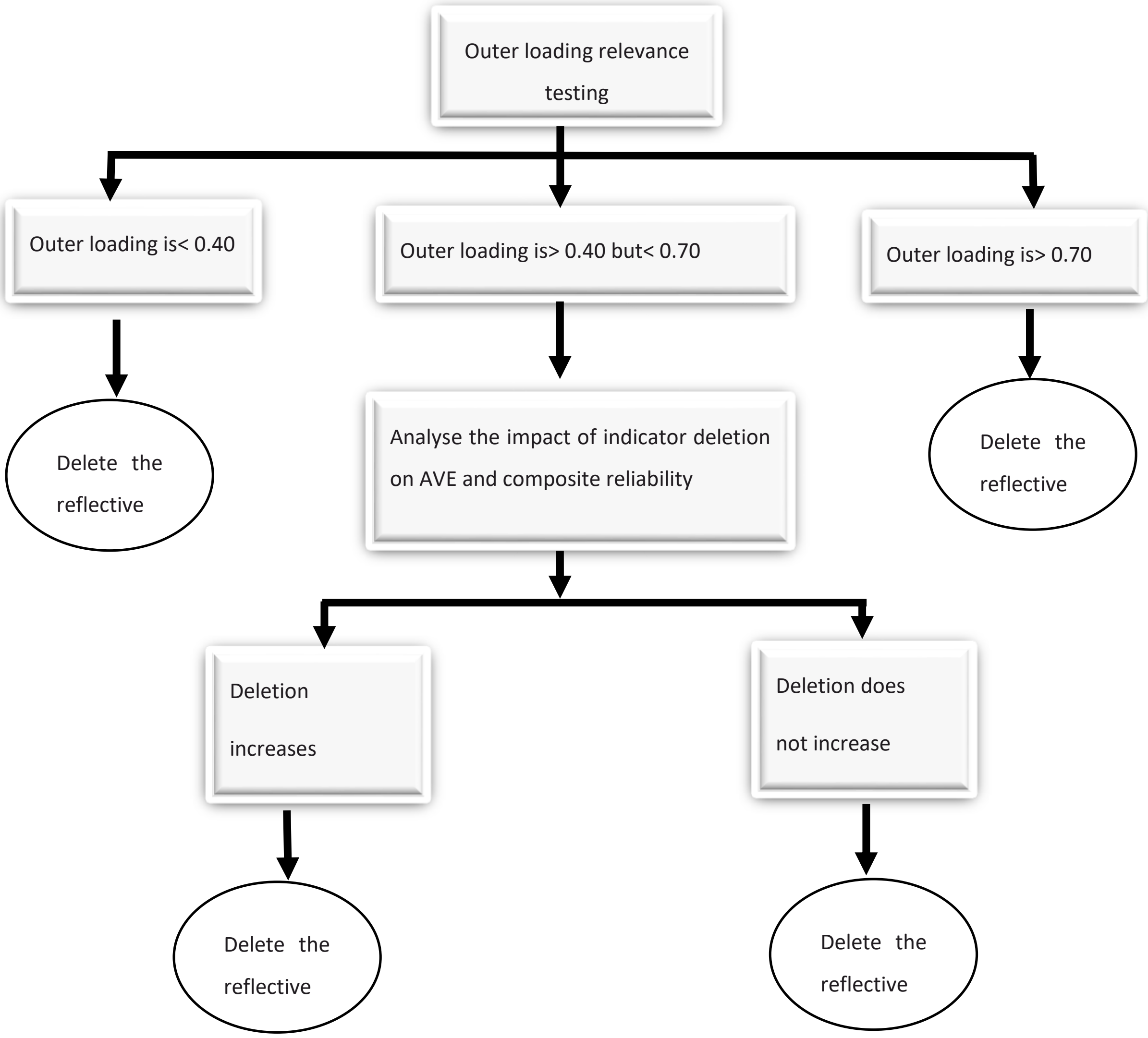


Figure 4.2: Outer loading relevance testing

Adapted from Hair et al. (2014, p 114)

4.7.4.1.4 Assessing the Discriminant Validity

Discriminant validity is "… the extent to which a construct is truly distinct from other constructs by empirical standards." (Hair et al., 2014, p 104). Therefore, establishing discriminant validity indicates that a construct is different from others and it is the only construct in the model capturing that phenomena. The cross-loading, Fornell-Larcker's criterion and Heterotrait-monotrait ratio (HTMT) are the three tests used to assess discriminant validity (Garson, 2016; Hair et al., 2014).

- **Cross-loadings**

Cross-loading is obtained by correlating each component score with all the other indicators (Chin, 1998). Discriminant validity is established if an item's loads in its associated construct are higher than its loadings with all other constructs. The item's outer loading on the associated latent variable must be bigger than any of its cross-loadings on other latent variables.

- **Fornell-Larcker's criterion**

Using Fornell-Larcker's criterion requires the latent variable to share more variance with its assigned indicators than with any other latent variable (Hair et al., 2014). Therefore, the square root of the average variance extracted should be bigger than its correlation with any other construct. In SmartPLS 3 output, the Fornell-Larcker criterion table, the square root of AVE appears in the diagonal cells and correlations appear below it (Hair et al., 2014). Therefore, if the number on the top of each factor column is greater than the numbers under it, discriminant validity is attained.

- **Heterotrait-monotrait ratio (HTMT)**

Traditionally the Fornell-Larcker criterion and cross-loadings are accepted methods of assessing the discriminant validity. However, SmartPLS 3 documentation noted that the Fornell-Larcker criterion and cross-loadings have shortcomings. The HTMT ratio is the preferred measure of discriminant validity (Henseler, Ringle, & Sarstedt, 2015). According to Henseler, Ringle, and Sarstedt (2015) the HTMT value below 0.90, indicates that discriminant validity has been established. Gold, Malhotra, and Segars (2001) also use the 0.90 cut-offs, though some researchers (Clark & Watson, 1995; Kline, 2011) use the more stringent cut-off of 0.85. Table 4.5 shows the summary of the guidelines used to evaluate the reliability and validity of a reflective outer model.

Table 4.5: Validity and reliability guidelines for assessing reflective measurement model

Validity Type	Criterion	Guidelines
Internal consistency	Composite reliability	CR > 0.6 (for exploratory study) CR > 0.8 (advance research) CR < 0.6—lack of reliability
Indicator reliability	Indicator loadings	Item's loading > 0.7 and significant at least at the 0.05 level
Convergent validity	AVE	AVE > 0.50
Discriminant validity	Cross loading Fornell and Larcker Heterotrait-monotrait ratio	Item's loading of each indicator is highest for its designated construct. The square root of the AVE of a construct should be greater than the correlations between the construct and other constructs in the mode HTMT < 0.9

Thus, in this study, the outer model's validity and reliability are satisfactory when:

1. Composite reliability is bigger than 0.6.
2. The indicator's loading is bigger than 0.7 and is significant at the 0.05 level. Items with outer loadings between 0.40 and 0.70 should be removed only if the removal increase in CR above 0.6 and AVE above 0.5.
3. AVE value of every latent variable should be greater than 0.50.
4. The factor's loading of each item should be the biggest for its designated latent variable.
5. The square root of the AVE of a latent should be higher than the correlations between the latent variable and other the latent variables in the model.
6. HTMT < 0.9.

Removal of indicators was conducted with care since the removal of items may increase the discriminant validity or reliability but simultaneously decrease the content validity of the measurement scale.

4.7.5 Structural Model

Once the outer model was established to be valid and reliable, the second step was the evaluation of the inner model. Validating the inner model results help the researcher to determine how well the empirical data support theory. Furthermore, assessing the inner model also helps in deciding whether the theory has been empirically confirmed (Hair et al., 2014). In PLS-SEM, this process involves examining the model's predictive capabilities (R-squared) and the relationships between the constructs (path coefficients). Figure 4.3 shows the systematic approach used to assess the results of the inner model.

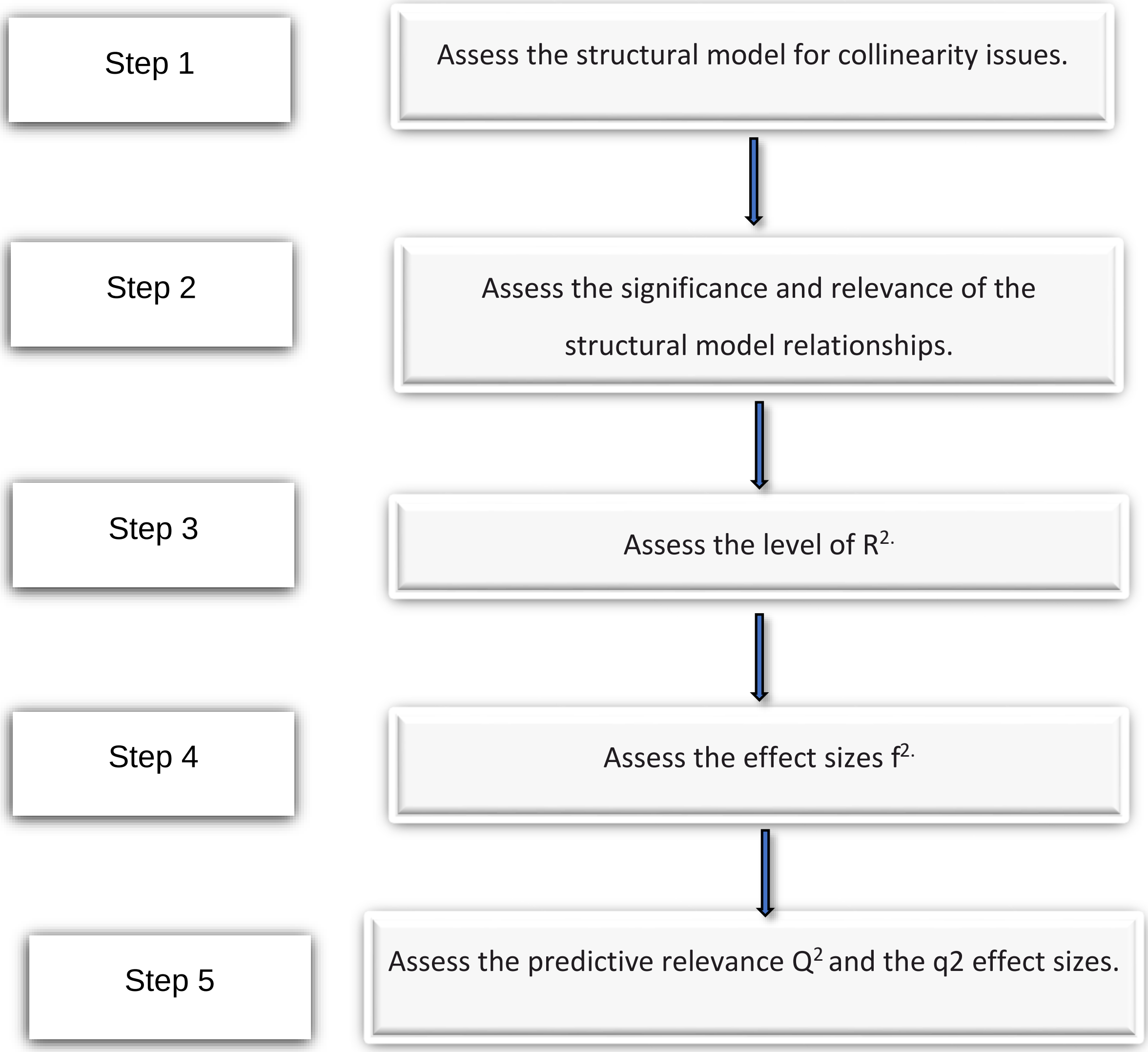


Figure 4.3: Structural Model Assessment Procedure

Source: Adapted from Hair et al. (2014, p. 169)

4.7.5.1 Step 1: Multicollinearity in Reflective Models

Multicollinearity exists when two or more exogenous variables are highly intercorrelated (Garson, 2016). In PLS-SEM, multicollinearity inflates standard errors and prevents the researcher from assessing the relative importance of one exogenous variable compared to another (Hair et al., 204). According to Garson (2016), the rule of thumb is that the variance inflation factor (VIF) coefficient of less than 4.0 show that there are no problems of multicollinearity. However, researchers like Hair et al. (2014) use a more lenient cut-off of 5.0.

4.7.5.2 Step 2: Structural Model Path Coefficients

The PLS-SEM algorithm was run to obtain the structural model relationships (path coefficient). These path coefficients represent the hypothesized relationships among the latent variables. The standardized values of the path coefficient are between -1 to +1. A standardized path coefficient close to 1 indicates strong positive relationships (and the opposite is true for negative values) that are almost always statistically significant (Hair et al., 2017). The closer the path coefficient to 0, the weaker the relationship and are usually nonsignificant. To determine whether a path was significant or not, the bootstrapping method was used. The minimum number of bootstrap subsamples should be 5 000 (Hair et al., 2014). According to Hair et al. (2014), the commonly used critical values for two-tailed tests are 1 .65 (significance level= 10%), 1.96 (significance level = 5%), and 2.57 (significance level = 1 %. This study assumes a significant level of 10% due to its exploratory nature (Hair et al., 2014).

4.7.5.3 Step 3: Coefficient of Determination (R-squared value)

The widely used measure to assess the inner model is the coefficient of determination (R-squared value). The R-squared coefficient is a measure of the model's predictive accuracy, and it represents the exogenous variables' combined effects on the endogenous variable. According to Chin (1998) and Hock and Ringle (2006), the results above the cut-offs 0.19, 0.33 and 0.67 are considered to be “weak”,” moderate” and “substantial”.

4.7.5.4 Step 4: Effect Size f-squared

The R-square change effect is also known as the f-square effect size. The f-square equation shows the effect of removing an exogenous variable on the R-squared value. In other words, it shows the contribution of the exogenous variable on the R-squared value (Hair et al., 2014). According to Garson (2016), the f-square values of 0.02, 0.15 and 0.35 respectively represent a small, medium, and high effect of the exogenous latent variable.

4.7.5.5 Step 5: Blindfolding and Predictive Relevance Q-squared

In Smart PLS 3, the cross-validated redundancy for a reflectively model endogenous factor is the Stone-Gleisser Q- squared value (Garson, 2014; Hair et al., 2014). In this study, the cross-validated redundancy was used to assess predictive relevance (Q-squared). A Q- squared value above 0 indicates that the model is relevant to predicting that factor.

4.7.5.6 Multigroup Analysis

Section 5.7.4.1 to 5.7.5.5 gives insights on how rural high school STEM learners', their teachers' and parents' models were evaluated. This section continues by giving insights about how these models were compared using multigroup analysis. The data for parents, learners, and teachers were combined to form one data file. The combined model was evaluated as explained from section 5.7.4.1 to 5.7.5.5. Then, the multigroup analysis was then performed, and the following criteria were used to assess the results are the parametric test and the Welch-Satterthwait test.

In this study, the parametric test and the Welch-Satterthwait test were used. The parametric test assumes that groups have equal variances while the Welch-Satterthwait test assumes that the groups have unequal variances between groups. These two tests find if there is a significant difference between the two groups by comparing the path coefficients of these groups. The tests find a difference to be significant if the p-value is smaller than 0.05 or larger than 0.95 for the difference of group-specific path coefficients (Hair et al., 2017).

4.8 Data Collection and Analysis for Phase Two

4.8.1 Phase two – Qualitative Data using Interviews

Phase Two of this study involved interviewing rural high school STEM learners, their parents, and teachers. Unlike in Phase One, Phase Two allows the participants to meet the researcher. Interviews are more suitable when the information needed is detailed, complex and open-ended, as they allow the investigator to examine the participants' perceptions. Oates (2006) stated that when a study involves sensitive issues, the respondent may find it hard to describe in writing or may not wish to write certain experiences, thus interviews became vital. In this research, the scholar sought to find out detailed information in areas like educators' perceived skill readiness and how they felt about possibly appearing to possess less mobile learning technical skills than learners. These issues are sensitive and are often best handled in an interview.

A group interview was selected in the current study. A group interview is a "group comprised of individuals with certain characteristics who focus discussions on a given issue or topic" (Dilshad & Latif, 2013). The author added that the group consists of a small number of people who are brought together by the researcher to explore feelings, attitudes, and perceptions about a topic (Dilshad & Latif, 2013). In the current study rural high school STEM grade 12 learners, their parents, and teachers were chosen to explore their feelings, attitude, and perceptions of using mobile learning for learning STEM-related subjects. To ensure homogeneous participants were in the same group, learners, teachers, and parents formed their groups. Putting participants in different groups ensured that interaction happened to an optimum level and to avoid other participants from dominating (for example teachers dominating learners and parents) or withdraw (learners might be afraid to express their options in front of their parents and teachers) from the interview.

4.8.2 Piloting the Interview

The interview questions were translated from IsiZulu with the help of a research assistant. The researcher and the research assistant piloted the interview at the school they were working at. They asked STEM teachers and learners to be participants of the pilot study. The teachers and learners who participated assessed whether the language used was clear and whether the researcher will be able to get the required response from the questions. The pilot study was used to get approximate time the interview required. The interview revealed that even though the tape recorder was being used, but the translation was going to be difficult as participants sometimes talked simultaneously. As a result, the researcher and the research participants agreed on giving each participant time to respond without being interrupted. This ended up being very handy in the actual interviews as the participants were not tape-recorded.

A consent form was signed just before the interview. After the pilot interview, the participants gave feedback on the suitability and clarity of some questions. Some of the questions were reworded according to the feedback from the participants. The resulting interview schedule is displayed in Appendix 4.1.

4.8.3 Conducting the Interviews

The researcher and the participants' home language were different as a result a bilingual research assistant was used (Rice & Ezzy, 1999). The researcher followed the suggestion by Dilshad and Latif (2013), who suggested that the session should start with a transitional period where the participants were served with some refreshments. During this period, the researcher and the research assistant had small talks to make sure that the participants were at ease. After the refreshments, the research assistant started the formal group session by thanking the participants for volunteering to be part of the interviews. The research assistant asked if the interviews can be recorded but in all the three groups at least one of the participants objected, as a result, note-taking was the method used in recording participants' responses. The research assistant emphasized the rules of confidentiality and asked them to ask for explanations if they did not understand the question properly. The participants were given a number, for instance, there were three parents, so the participants were named P1, P2, and P3. The participants were also told that they can only talk when they are given the opportunity to, this was done so that the researcher and the research assistant could record all the participants' responses.

The research assistant introduced the questions one by one and gave each participant a chance to answer the question without expressing any value on the answer provided (Anderson, 1990). The research assistant also encouraged participants not to commend on other respondents' responses unless it is an addition. As recommended by Rice and Ezzy (1999), respondents were encouraged to use IsiZulu in expressing themselves, but the questions were asked in both the languages (IsiZulu and English). The interviews were scheduled to take 30 minutes, but the longest one was the one with learners which end up taking one and a half hours. This was because the learners were more interested in the topic and the next question was only asked after the response of the previous question was recorded since there was no tape recording. However, all the interviews were conducted within the two hours maximum duration submitted by Rice and Ezzy (1999). After the session, the researcher thanked all the participants for their valuable contribution.

4.8.4 Translation

Since notetaking was used to record the response of the interviewees there was no need for transcribing. However, the responses were recorded as close to verbatim as possible. This was done because the study required the actual quotations by participants to exemplify key points in the analysis. For some of these quotations which were in IsiZulu, they were carefully translated to English to ensure that the exact meaning was returned. Following the assessment by Easterby-Smith, Thorpe, Jackson, and Lowe (2008), the accuracy of IsiZulu to English translations were established by re-translating the English quotations to IsiZulu.

4.8.5 Data Analysis for Phase Two

The thematic analysis was used to analyse qualitative data in this phase. According to Boyatzis (1998), thematic analysis involves the identification, analysis, and reporting of emerging patterns found in the data collected. This method has a merit that it is flexible, but it needs careful planning and implementation. The researcher had the role of choosing which themes to be selected, not that the themes just emerge from the data (Braun & Clarke, 2006).

The deductive thematic approach was used, in which the propositions to be tested were derived from the Technology Acceptance Model (Saunders et al., 2009). The key themes and patterns to be identified in the data were determined before the analysis and were actively generated by the type of questions asked in the interview. A deductive approach is criticized for failing to pick vital themes that might be contained in the conceptual framework (Zalah, 2018a). However, in the current study, the approach was the most appropriate as the objective of carrying out these interviews was to explain the findings of the results of the quantitative approach.

4.9 Ethical Consideration

To confirm that the research complies with the University research ethics, the researcher was given an ethical clearance letter by the University of Zululand research ethics committee (UZREC). Questionnaires were administrated to twelve schools in the King Cetshwayo District in KwaZulu-Natal. The researcher applied for permission to conduct the study in schools from the Provincial Head of Department of Education, who granted permission in the form of an approval letter (Annexure G). The approval letter from the Provincial Head of Department of Education, copies of the questionnaires and university ethical clearance were sent to the District Director to ask for permission to conduct the study in the district. Verbal approval was given by the District Director. The Provincial Head of Department of Education’s approval letter and the questionnaires were then taken to the school principals to ask for permission to carry out the study and verbal approval was given by the school principals.

A consent letter explaining the purpose of the research; expected duration of the participants' participation; procedures used in the research; participants' right to decline to participate; and withdraw participation at any time, and the consequences of withdrawal were given to participants. The participants were also made aware of the benefits of the research, and the confidentiality of the data collected. For learners under the age of 18, parental consent was solicited, as well as the participants' consent. The data was collected from participants anonymously and any personal information that could be used to identify participants was not requested. Lastly, all the data collected from the participants were treated with confidentiality and were only used for the current study.

The environment where the interviews were conducted was such that it did not pressure the interviewee in any way. The interviewees were also asked for the time and a day that was convenient for them. The participants were asked if the interviews could be tape-recorded, of which some of them refused and so tape recorders were not used. The interviewees were made to sign the consent form before the interviews. The researcher also explained that the notes taken did not have people's names but rather codes so that the participants would remain anonymous. Additionally, the data was safely kept by the researcher and it was destroyed once it has served its purpose.

To ensure that teaching and learning at schools were not disturbed by the researcher's data collection activities, the researcher was given time slots that were convenient for the schools by the school principals. For example, all the interviews were done after working hours and questionnaire administration was done during school breaks.

To ensure the creditability of the results, the researcher used the "tactics to help ensure honesty informants when contributing data" (Shenton, 2004). The researcher made sure that data was collected from willing participants. The researcher also encouraged the participants to be honest from the onset of the interview session. The researcher also reported the research findings as honest as possible, without suppressing, falsifying, or inventing them to meet the researcher's needs.

To ensure dependability, the researcher reported the processes within the study in detail. This ensures that future studies can repeat the study. To ensure trustworthiness, the researcher maintained the databases so that the research can be audited and used the quotations of research participants in a written research report. This was done to enable the reader to be the independent judge concerning the qualities of the analysis. Auditability provides for replication and also promotes rigor in both data collection and analysis (Bisman, 2010). To enable auditability, the documentation was maintained following data collection, thus promoting reliability and validity.

4.10 Summary

The methodology and approaches that were used in this study were discussed in this chapter. The chapter outlined that the underlying research philosophy was a pragmatic paradigm. The chapter also discussed the ontological, epistemological, axiology, logical and methodological positions of the study and the research design.

A mixed-methods approach, with an explanatory-sequential design, was employed in the current study. This design started with quantitative methods followed by qualitative methods. After the research design, the next subsection outlined the population, sampling procedures and the sample size of the study. The data collection method subsection then followed. This subsection addressed instrumentation questionnaires, interviews, and reliability analysis of the instrument. Quantitative and qualitative data analysis was employed in the study. In conclusion, the ethical considerations of the study were discussed.

CHAPTER 5 QUANTITATIVE DATA ANALYSIS

5.1 Introduction

Chapter 5 presents the empirical findings of the current research. The analyses were carried out using the statistical techniques discussed in Chapter 4. This chapter is presented in six sections. After the introduction, section 5.2 expounds the screening of the data with essential statistical techniques and the output, such as missing data treatment, outlier examination, normality, and data screening. Using the screened data, section 5.3 gives the descriptive statistics of the respondents' demographic characteristics. Section 5.4 describes the descriptive statistics of the instrument. Section 5.5 explains the inferential analysis through partial least squares (PLS) and presents the reliability and validity of the instruments. The section also presents results of the factors that affect rural high school STEM learners', their teachers', and parents' acceptance of mobile learning.

5.2 Data Preparation

The first stage of data analysis is data preparation and description. Data preparation includes processes like editing, coding, and data entry. This activity ensures the accuracy of data and the process of converting raw data into forms that are more suitable for analysis (Cooper & Schindler, 2008). The data was coded and then edited to ensure its accuracy and consistency, as well as to check if there was any missing data. Once data editing was complete, the data was ready to be analysed and interpreted.

5.2.1 Coding

According to Cooper and Schindler (2008), the coding process involves assigning numbers to the answers that were provided by the respondents to group the response into a limited number of categories. In this thesis, both pre-coding and post coding was used. Pre-coding is the allocation of codes before the responses are provided (Hair et al., 2014). All the questions in section B of the questionnaire were allocated a code during the design of the questionnaire. For example, all the questions used a 7-point

Likert scale with the categories (1) strongly disagree, (2) disagree, (3) somewhat agree (4) neutral (5) somewhat agree, (6) agree, and (7) strongly agree. Additionally, all the questions on the questionnaire were allocated an item code, for example, question 2 on the latent variable perceived usefulness was assigned PU2 as its code. Each question on the questionnaire represents a measurement item for its representative latent variable.

Post-coding is the assigning of codes after the respondent has answered the question on the questionnaire (Hair et al., 2014). All the questions in section A were post-coded. For example, on the question of gender, 1 was allocated to females and 2 to males. Once the coding was done, the data were then entered into a Microsoft Excel spreadsheet. After all the data were entered, the process of editing began.

5.2.2 Editing

As pointed out by Cooper and Schindler (2008), the purpose of editing is to ensure that all the data is captured, accurate, consistent with the intention of the question and uniformly entered. Editing is also necessary to check if there are no omissions. Once editing was complete, a data source was created and saved as a comma-separated values (.csv) file, the format used by SmartPLS 3 software to analyse data.

5.2.3 Data Screening

After the coding and editing stages, the screening stage in which screening for outliers and missing data was conducted. This was to ensure that there was no missing data and data was entered correctly (Sapsford & Jupp, 2006). In this thesis, all observations with missing values were deleted (Hair et al., 2014). This method was preferred as there was no risk of deleting certain groups of respondents. Additionally, even though deleting the cases diminishes the number of observations in the data set, the remaining number of observations was sufficient to get valid and reliable results using PLS-SEM (Hair et al., 2014).

Sixteen cases were removed because of missing data. An additional eleven more cases were removed because the cases had the same answer for all questions (for example, answered 1 for all questions). After the preliminary scrutiny, all 417 usable cases were stored as the source file, while 27 cases were removed from the data set.

5.2.4 Assessment of Outliers

An outlier is a case with values well above or below the rest of the other cases (Pallani, 2010). From the Statistical Package for Social Sciences (SPSS), Malahanobis distance was used to check for outliers. A new variable (mah_1) was created. This value was compared against a critical value, and any value (mah_1) greater than the critical value was considered a critical value. In these cases, five out of the 417 cases were higher than the critical value. Following Pallani's (2010) suggestion, the cases were not removed. However, every outlier case was assessed to see if it was because of capturing data incorrectly. In all these cases, the data was not entered incorrectly.

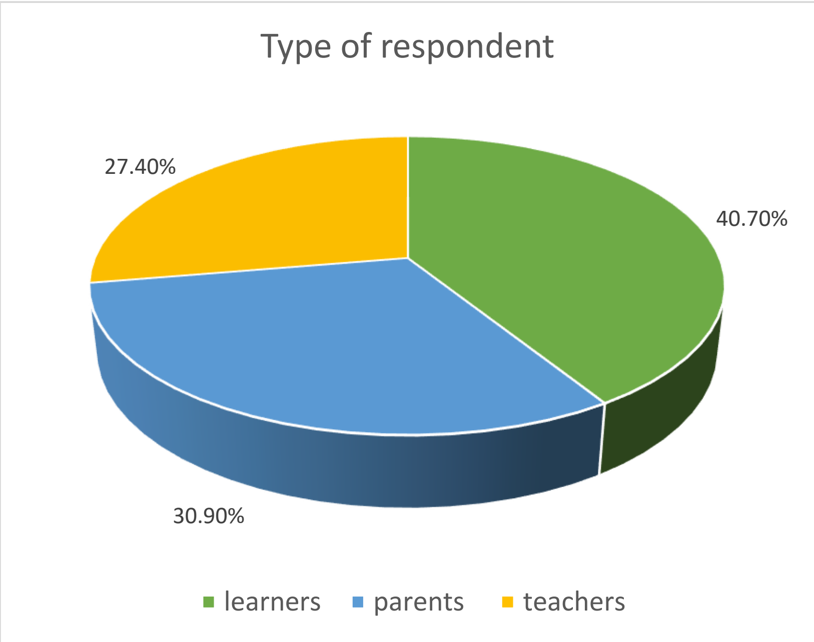
5.2.5 Normality test

The data normality test in this study was examined using SPSS's skewness and kurtosis. This was primarily because, according to Hair et al. (2017), the Kolmogorov-Smirnov tests and Shapiro-Wilks tests only indicate whether the data follow a normal distribution or not, without indicating the extent to which the data differ from a normal distribution if the data is not normally distributed. The results showed that data distribution was not normally distributed. Table 5.3 shows the results of skewness and the kurtosis of each construct. The results showed that only item PR2 presented skewness above the recommended threshold, – 3 to +3, while more than 40% of the data presented kurtosis above the recommended threshold. All the data presented a kurtosis above the suggested cut-off kurtosis value of +3 which meant that the distribution was too peaked. Therefore, the data did not follow the normal distribution curve, and thus additionally justifying the use of PLS-SEM.

5.3 Descriptive Statistics of Respondents

The descriptive statistics of respondents give insight into the demographic profile of respondents who participated in the survey. The response rate was 80% (444 out of 550 questionnaires were collected). However, 76% (417 responses) were used in this study, while 27 responses were removed during the data screening. Table 5.1 shows the types of respondents in this study.

Table 5.1: Type of the respondents

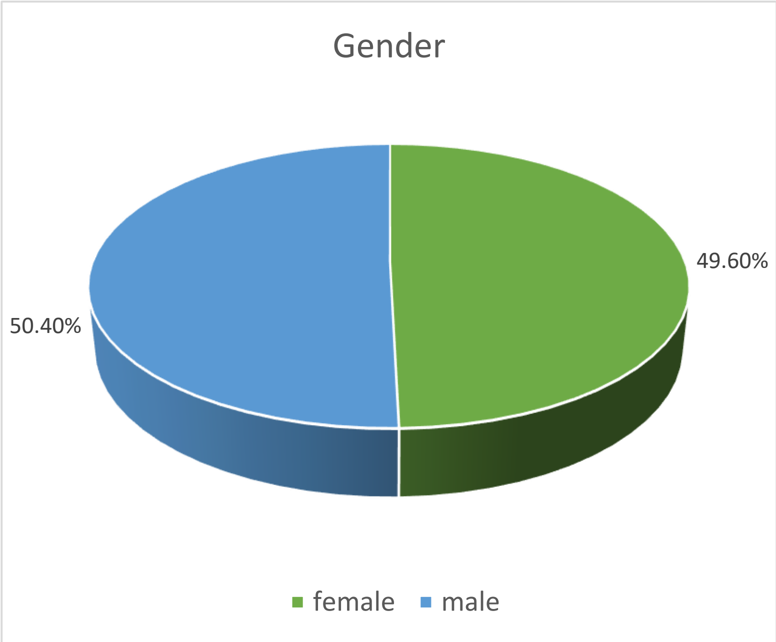


Respondent	Count	Percentage
Learners	174	40.7
Parents	129	30.9
Teachers	114	27.4

Among the respondents 40.7% were rural high school grade 12 STEM learners, 30.9% were their parents and 27.4% were their teachers. Table 5.2 shows the gender of the respondents.

Table 5.2: Gender of the respondents

What is your gender?



Respondent	Count	Percentage
Female	207	50.4
Male	210	49.6

Of the respondents, 50.4% were males and 49.6% were females.

5.4 Descriptive Statistics of the Instrument

Using the statistical software SPSS version 25, standard deviation, minimum value, the mean and maximum value of each indicator were assessed. The descriptive statistics of all indicators are shown in Table 5.3.

Table 5.3: The descriptive statistics of the instrument

Construct	Indicator	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
							Statistic	Std. Error	Statistic	Std. Error
Perceived usefulness	PU1	417	2	7	6,66	0,727	-2,575	0,120	7,775	0,238
	PU2	417	3	7	6,60	0,740	-2,141	0,120	4,960	0,238
	PU3	417	2	7	6,55	0,819	-2,100	0,120	4,766	0,238
	PU4	417	1	7	6,47	0,869	-2,167	0,120	6,411	0,238
	PU5	417	2	7	6,54	0,771	-2,108	0,120	5,735	0,238
Perceived attitude towards the use	ATT1	417	1	7	6,12	1,185	-1,521	0,120	2,204	0,238
	ATT2	417	1	7	5,67	1,314	-1,326	0,120	2,154	0,238
	ATT3	417	2	7	5,97	1,088	-0,903	0,120	0,351	0,238
	ATT4	417	1	7	6,02	1,087	-1,232	0,120	1,860	0,238
	ATT5	417	1	7	5,96	1,190	-1,352	0,120	2,201	0,238
Behavioural intention	BI1	417	1	7	6,36	0,951	-1,727	0,120	3,592	0,238
	BI2	417	1	7	5,59	1,483	-1,221	0,120	1,242	0,238
	BI3	417	1	7	6,11	1,138	-1,446	0,120	2,166	0,238
Perceived ease of use	PEOU1	417	1	7	6,27	1,047	-2,023	0,120	5,162	0,238
	PEOU2	417	2	7	6,14	1,030	-1,417	0,120	2,038	0,238
	PEOU3	417	1	7	6,11	1,044	-1,639	0,120	3,848	0,238
	PEOU4	417	1	7	6,45	0,989	-2,560	0,120	7,814	0,238
	PEOU5	417	1	7	6,41	1,005	-2,405	0,120	7,031	0,238
Perceived resources	PR1	417	1	7	5,31	1,140	-1,683	0,120	2,077	0,238
	PR2	417	2	6	5,79	0,641	-3,692	0,120	14,848	0,238
	PR3	417	1	5	3,83	1,267	-0,727	0,120	-0,596	0,238
	PR4	417	1	7	3,80	1,900	0,026	0,120	-1,156	0,238
Perceived psychological readiness	PPR1	417	1	7	6,15	1,217	-1,808	0,120	3,647	0,238
	PPR2	417	1	7	5,55	1,506	-1,119	0,120	0,966	0,238
	PPR3	417	1	7	5,81	1,446	-1,399	0,120	1,650	0,238
	PPR4	417	1	7	6,13	1,120	-1,736	0,120	3,675	0,238
Perceived skills readiness	PSR1	417	1	7	5,86	1,215	-1,033	0,120	0,839	0,238
	PSR2	417	1	7	5,81	1,218	-1,114	0,120	1,201	0,238
	PSR3	417	1	7	5,90	1,250	-1,330	0,120	1,898	0,238
Perceived enjoyment	PEN1	417	1	7	6,30	0,980	-1,827	0,120	4,064	0,238
	PEN2	417	1	7	4,93	1,431	-1,228	0,120	0,532	0,238
	PEN3	417	1	6	5,46	1,096	-2,459	0,120	5,979	0,238
Perceived social influence	PSI1	417	1	7	5,61	1,551	-1,030	0,120	0,575	0,238
	PSI2	417	1	7	5,64	1,558	-0,949	0,120	0,071	0,238
	PSI3	417	1	7	5,64	1,491	-0,890	0,120	-0,004	0,238
Perceived ease to collaborate	PEC1	417	1	7	5,37	1,547	-0,806	0,120	0,092	0,238
	PEC2	417	1	7	5,47	1,404	-0,735	0,120	0,127	0,238

5.5 Analysis and Results of the PLS Approach

The hypotheses developed in chapter 3 was tested using SmartPLS 3's PLS-SEM. Based on the two-step approach suggested by Hair et al. (2014) and Chin (1998), the outer model was assessed first and then the inner model. Once the quality of the outer model achieved the acceptable standard as described in Section 4.7.4.1, the inner model was then assessed to test the causal relationships between the exogenous and endogenous variables (see Section 4.7.5.1).

The subsections that follow present the results of the following objectives:

Objective 1: Factors that affect rural high school STEM learners' acceptance of mobile learning (Section 5.5.1).

Objective 2: Factors that influence parents of rural high school STEM learners to accept mobile learning (Section 5.5.2).

Objective 3: Factors that affect rural high school STEM teachers' acceptance of mobile learning (Section 5.5.3).

Objective 4: Is there a statistical difference between learners' and their parents' and teachers' attitudes towards mobile learning (Section 5.5.4).

5.5.1 Objective 1: Factors that Affect Rural High School STEM Learners' Acceptance of Mobile Learning

5.5.1.1 Learners' Acceptance of Mobile Learning Model's Outer Model Assessment

The learners' acceptance of mobile learning model's outer model was tested using partial least squares (PLS). Smart PLS 3 was used to evaluate the learners' acceptance of mobile learning model's outer and inner models. This statistical program assesses the psychometric properties of the outer model and estimates the parameters of the structural model (Hair et al., 2017). The measurement model (outer model) was examined to ensure the survey questionnaire was accurately measuring that which it is supposed to measure, and simultaneously making sure that the instrument is reliable. According to Hulland (1999), the measurement model adequacy can be assessed by looking at internal consistency reliability, indicator reliability, convergent validity, and discriminant validity. The results of each of the analyses that were used to assess the validity and reliability of the learners' acceptance of mobile learning model's outer model are presented in the following subsections.

5.5.1.1.1 Internal Consistency Reliability of Learners' Measurement Model

For the formative measures, construct reliability can be assessed using the Cronbach's alpha and the composite reliability (Sánchez-Franco, 2006). Composite reliability gives a more accurate estimate than the Cronbach's alpha. An outer model had an acceptable internal consistency reliability when the composite reliability of each latent variable is greater than the cut-off value of 0.7 (Hair, Hult, et al., 2014). The composite reliability values of the learners' acceptance of mobile learning model's outer model ranged from 0.742 to 0.973, indicating acceptable internal consistency reliability, as they are all above the threshold value of 0.7. These results are shown in Table 5.1.

5.5.1.1.2 Indicator Reliability of Learners' Measurement Model

In this study, the scales were adapted from instruments provided by (Mathieson, Peacock, & Chin, 2001; Pan, 2003; Siegel, 2008). Indicator reliability for these indicators was not tested in their respective studies; the researchers only reported their internal consistency reliability. Furthermore, some of the measurement indicators (for example, PEC1, PEC2 and PEC3) were newly developed, based on previous studies on mobile learning. Thus, to minimize the errors in the outer model and to enhance the precision and validity of the scales and exploratory power of the developed model, a conservative value of 0.70, as suggested by Hair et al. (2014) and Sánchez-Franco (2006), was used as the threshold value. However, before the removal of indicators with loadings lower than 0.70, their potential practical significance was meticulously investigated (see Section 4.7.4.1.2).

Using SmartPLS 3 software, iterative evaluation of outer loadings was done based on the 0.70 rule of thumb (Hair et al., 2017). The indicators with outer loadings of less than 0.70 were removed one by one after each run. This process was repeated until only three indicators (PR1 = 0.662; PEN2 = 0.567 and PEN3 = 0.592) with loadings below 0.70 remained. These three indicators were not removed because deleting them did not increase the composite reliability above the threshold of 0.7 and AVE to be above 0.5 (Hair et al., 2017). Table 5.4 shows the outer loadings of all the indicators used in the final learners' measurement model. Most of the indicators have loadings greater than 0.70, which suggests that less than 50% of an item's variance was owing to error. Generally, the items presented an acceptable level of individual reliability.

5.5.1.1.3 Convergent Validity of Learners' Measurement Model

In the current research, the convergent validity was assessed using the broadly accepted method, average variance extracted (Fornell & Cha, 1994; Hair et al., 2014; Tabachnick & Fidell, 2007). According to Hair et al. (2014), constructs that have an AVE value of 0.5 or more are considered to have adequate convergent validity. The results of convergent validity shown in Table 5.4 show that the AVE values of all the latent variables ranged from 0.502 to 0.924. These AVE values are greater than the acceptable cut-off value of 0.5. The learners' acceptance of mobile learning model has established an acceptable convergent validity, which indicates that the items were measuring their associated latent variables well and they were not measuring other latent variables.

Table 5.4: The learners' acceptance of mobile learning measurement model

Construct	Item	Loadings	Cronbach's Alpha	Composite Reliability	AVE
Perceived skills readiness (PSR)	PSR1	0.910	0.848	0.907	0.766
	PSR2	0.905			
	PSR3	0.806			
Perceived enjoyment (PEN)	PEN1	0.913	0.616	0.742	0.502
	PEN2	0.567			
	PEN3	0.592			
Perceived social influence (PSI)	PSI1	0.951	0.959	0.973	0.924
	PSI2	0.978			
	PSI3	0.956			
Perceived ease to collaborate (PEC)	PEC1	0.932	0.863	0.916	0.785
	PEC2	0.888			
	PEC3	0.834			
Perceived psychological readiness (PPR)	PPR1	0.868	0.872	0.922	0.797
	PPR2	0.895			
	PPR3	0.914			
Perceived resources (PR)	PR1	0.662	0.706	0.832	0.625
	PR3	0.890			
	PR4	0.804			
Perceived usefulness (PU)	PU1	0.797	0.922	0.941	0.763
	PU2	0.881			
	PU3	0.884			
	PU4	0.891			
	PU5	0.911			
Perceived ease of usefulness (PEOU)	PEOU1	0.942	0.948	0.960	0.828
	PEOU2	0.911			
	PEOU3	0.877			
	PEOU4	0.901			
	PEOU5	0.918			
Perceived attitude towards the use (ATT)	ATT1	0.770	0.872	0.907	0.662
	ATT2	0.853			
	ATT3	0.884			
	ATT4	0.791			
	ATT5	0.760			
Behavioural Intention (BI)	BI1	0.769	0.767	0.866	0.684
	BI2	0.830			
	BI3	0.878			

Items removed: indicator items were below 0.5: - PR2, PPR4,

a. All item loadings >0.5 indicate indicator reliability (Hair et al., 2014).

b. All Cronbach's alpha > 0.7 indicate indicator reliability (Hair et al., 2014).

c. All Composite Reliability 0.7 indicate internal consistency (Hair et al., 2014).

d. All average variance extracted (AVE) > 0.5 indicate convergent reliability (Hair et al., 2014).

5.5.1.1.4 Discriminant validity of learners' measurement model

This study followed Garson's (2016) guidelines to use three assessment tools to examine discriminant validity and analysis of (a) cross-loadings, (b) Fornell-Larcker criterion and (c) Heterotrait-monotrait ratio (HTMT) (see Section 4.7.4.1.4).

5.5.1.1.5 Analysis of Cross-loadings of Learners' Measurement Model

A cross-loading assessment was conducted using SmartPLS 3 software. The output of the cross-loadings between the latent variables and items is shown in Table 5.5. Those denoted by the values in bold across constructs are its indicators. For example, perceived ease to collaborate (PEC), denoted by PEC1, PEC2 and PEC3, have loadings (0.932, 0.888 and 0.834) which are higher than indicator variables, such as ATT, PU and PSI in the same block. The results show that each item's outer loading on the associated latent variable was greater than all its loadings in other latent variables, and therefore demonstrate a discriminant validity of the constructs.

Table 5.5: Cross-loading analysis of learners' measurement model

	ATT	BI	PEC	PEN	PEOU	PPR	PR	PSI	PSR	PU
ATT1	**0.770**	0.442	0,104	0.036	0.185	0.098	0.213	0,063	0.028	0.270
ATT2	**0.853**	0.439	0,138	0,035	0.227	0.047	0.201	0,100	0.042	0.380
ATT3	**0.884**	0.577	0,065	0.013	0.337	0.056	0.283	0,100	0.050	0.471
ATT4	**0.791**	0.450	0.051	0.038	0.157	0.093	0.002	0.026	0.060	0.416
ATT5	**0.760**	0.433	0,083	0,071	0.132	0.127	0.202	0,106	0.061	0.313
BI1	0.475	**0.769**	0.038	0,087	0.257	0.020	0.125	0,031	0.066	0.404
BI2	0.475	**0.830**	0.050	0.008	0.285	0,014	0.209	0.114	0,023	0.336
BI3	0.493	**0.878**	0.113	0,070	0.305	0,011	0.110	0.135	0,035	0.492
PEC1	0,044	0.128	**0.932**	0.011	0.010	0.088	0,104	0.715	0.027	0.114
PEC2	0,055	0.106	**0.888**	0.028	0.000	0.087	0,093	0.699	0.058	0.111
PEC3	0,113	0.002	**0.834**	0.029	0.017	0.050	0,093	0.370	0,047	0.109
PEN1	0,015	0,097	0,043	**0.913**	0,196	0.411	0,046	0.020	0.344	0,065
PEN2	0.004	0.029	0.072	**0.567**	0,078	0.240	0.032	0.042	0.217	0,059
PEN3	0.032	0.037	0,033	**0.592**	0,078	0.181	0.004	0.016	0.301	0,120
PEOU1	0.254	0.292	0.034	0,153	**0.942**	0,061	0.187	0,035	0,062	0.303
PEOU2	0.259	0.295	0.017	0,166	**0.911**	0,030	0.192	0,096	0,032	0.320
PEOU3	0.193	0.238	0,011	0,159	**0.877**	0,028	0.203	0,090	0,073	0.231
PEOU4	0.274	0.375	0,021	0,150	**0.901**	0,068	0.133	0,099	0,027	0.405
PEOU5	0.214	0.336	0.031	0,195	**0.918**	0,078	0.117	0,055	0,062	0.326
PPR1	0.059	0,051	0.010	0.449	0,060	**0.868**	0.052	0,135	0.557	0.062
PPR2	0.111	0.006	0.065	0.244	0.007	**0.895**	0.091	0,132	0.565	0.138
PPR3	0.096	0.036	0.147	0.456	0,109	**0.914**	0.047	0,010	0.561	0.054
PR1	0.123	0.094	0.067	0,099	0.053	0.019	**0.662**	0,060	0.033	0.077
PR3	0.248	0.148	0.159	0.000	0.161	0.079	**0.890**	0,077	0.092	0.134
PR4	0.147	0.167	0.077	0.003	0.182	0.078	**0.804**	0,086	0.070	0.094
PSI1	0.124	0.054	0.632	0.028	0.085	0.107	0.135	**0.951**	0.082	0.040
PSI2	0.063	0.116	0.638	0.021	0.055	0.105	0.094	**0.978**	0.094	0.021
PSI3	0.059	0.100	0.631	0.040	0.099	0.085	0.040	**0.956**	0.055	0.025
PSR1	0.064	0.008	0.044	0.351	0.015	0.592	0.048	0.058	**0.910**	0.057
PSR2	0.040	0.026	0.014	0.380	0.071	0.600	0.106	0.055	**0.905**	0.058
PSR3	0.052	0.047	0.006	0.296	0.060	0.436	0.024	0.108	**0.806**	0.001
PU1	0.408	0.347	0.151	0.081	0.293	0.018	0.060	0.029	0.009	**0.797**
PU2	0.405	0.461	0.087	0.095	0.311	0.144	0.162	0.008	0.048	**0.881**
PU3	0.399	0.433	0.084	0.110	0.293	0.063	0.107	0.014	0.001	**0.884**
PU4	0.419	0.464	0.045	0.025	0.303	0.149	0.153	0.046	0.085	**0.891**
PU5	0.391	0.468	0.189	0.148	0.347	0.063	0.092	0.033	0.060	**0.911**

5.5.1.1.6 Fornell-Larcker Criterion of Learners' Measurement Model

The correlation matrix for the constructs is shown in Table 5.6. The numbers in bold in Table 5.6 represent the square roots of the AVE and the numbers that are not in bold represent the intercorrelation value between latent variables. The results show that the square root of each latent variable's AVE was larger than its highest correlation with any other latent variable (Fornell & Cha, 1994). Table 5.6 shows that none of the inter-construct correlation values were above the square-root of the AVE and satisfied the Fornell-Larcker criterion of the discriminant validity.

Table 5.6: Fornell-Larcker criterion of learners' measurement model

	ATT	BI	PEC	PEN	PEOU	PPR	PR	PSI	PSR	PU
ATT	**0.813**									
BI	0.581	**0.827**								
PEC	0.083	0.084	**0.886**							
PEN	0.004	0.060	0.022	**0.708**						
PEOU	0.265	0.342	0.011	0.181	**0.910**					
PPR	0.100	0.003	0.083	0.427	0.060	**0.893**				
PR	0.228	0.177	0.136	0.027	0.180	0.071	**0.791**			
PSI	0.087	0.092	0.659	0.030	0.083	0.103	0.094	**0.961**		
PSR	0.059	0.000	0.010	0.394	0.054	0.629	0.072	0.080	**0.875**	
PU	0.462	0.500	0.126	0.093	0.355	0.096	0.133	0.001	0.048	**0.874**

5.5.1.1.7 HTMT Test of Learners' Measurement model

The results of the HTMT test are shown in table 5.7. All the HTMT values in Table 5.7 were less than 0.90, indicating that discriminant validity has been established (Henseler, Ringle, & Sarstedt, 2015). All the measures of discriminant validity indicate that each latent variable in the measurement model was empirically distinguishable.

Table 5.7: Heterotrait-monotrait ratio of learners' measurement model

	ATT	BI	PEOU	PR	PSI	PU
ATT						
BI	0.706					
PEOU	0.278	0.395				
PR	0.276	0.236	0.207			
PSI	0.105	0.132	0.086	0.112		
PU	0.509	0.589	0.372	0.158	0.041	

Overall, the indicator reliability, internal consistency reliability, convergent validity and discriminant validity tests conducted on the learners' measurement model were satisfactory. Therefore, the learners' acceptance of mobile learning model's outer model showed the ample robustness needed to assess the structural model. Following the hypotheses depicted in Figure 3.5, the learners' acceptance of mobile learning model's measurement model, depicted in Figure 5.1, was formed. The learners' acceptance of mobile learning model's measurement model also shows the outer loadings of each construct (see Figure 5.1). The measurement model consists of ten latent variables. Four constructs (PSR, PEN, PSI, and PEC) are exogenous variables to PPR, PR, PU, PEOU, BI, and ATT, while five constructs (PPR, PR, PU, PEOU, and ATT) are exogenous to BI.

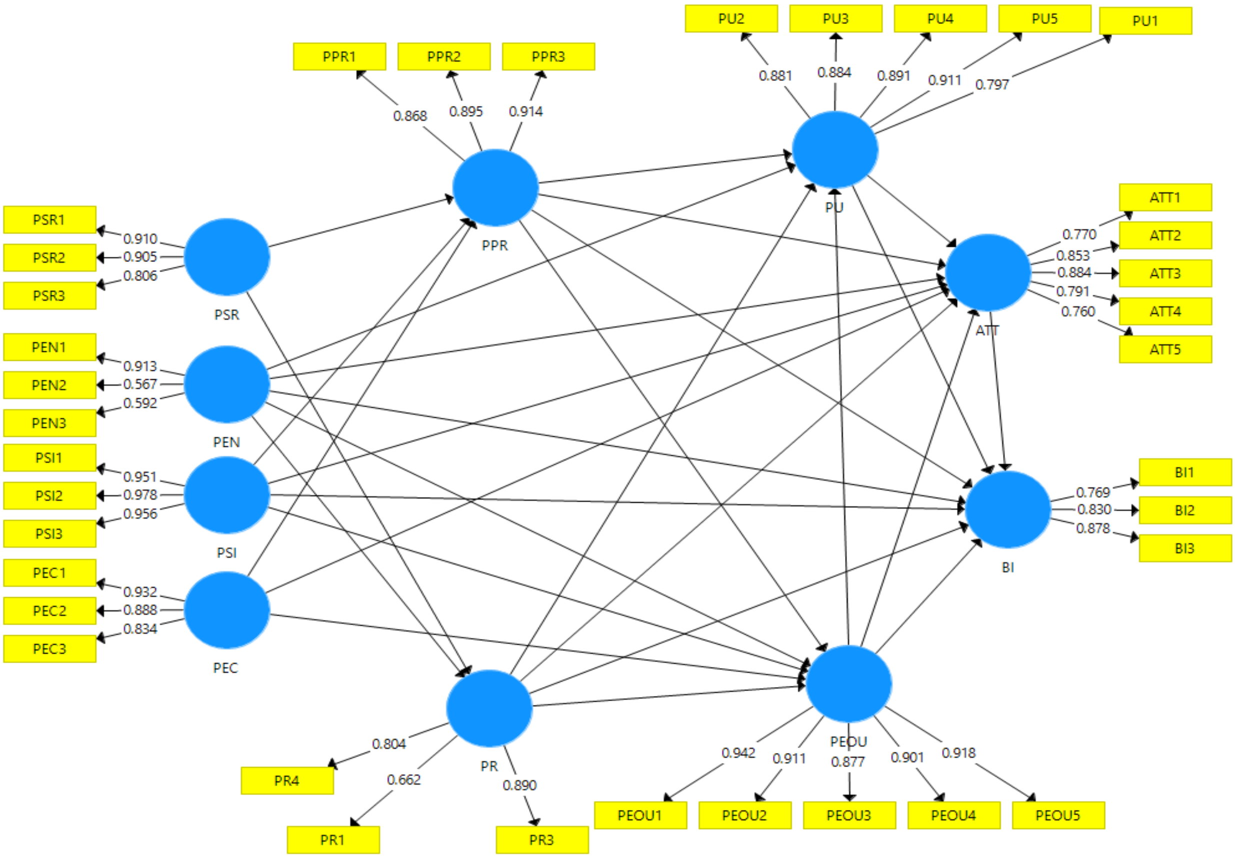


Figure 5.1: Learners' acceptance of mobile learning model's measurement model

With acceptable results for reliability and validity, the next step was to perform the analysis of the inner model, to test the research hypotheses of this study and to determine the explanatory power of the proposed learners' model.

5.5.1.2 Leaners' Structural Model Assessment

Section 5.5.1.1 provided insights into an assessment of the learners' acceptance of mobile learning model's outer model. This section discusses the results of the learners' structural model evaluation. The evaluation followed the five steps procedure recommended by Hair et al. (2014) and described in section 4.7.5.

Step 1: Collinearity assessment of learners' measurement model

The VIF values were used to assess collinearity. The VIF value above 5.00 in the exogenous latent variable is indicative of collinearity (Hair et al., 2017). The following sets of predictor constructs for collinearity were assessed: (a) PR and PEN as predictors of PEOU; (b) ATT, PEOU, PSI and PU as predictors of BI; and (c) PEC, PU and PR as predictors of ATT. Table 5.8 shows the results of the collinearity test.

Table 5.8: Collinearity assessment of learners' measurement model

First set (PEOU)		Second set (BI)		Third set (ATT)	
Predictor Construct	VIF Value	Predictor Construct	VIF Value	Predictor Construct	VIF value
PR	1.001	ATT	1.300	PEC	1.045
PEN	1.001	PEOU	1.168	PR	1.047
		PSI	1.015	PU	1.041
		PU	1.380		

All the VIF values of all predictors were less than 5, indicating that collinearity among the predictors was not an issue in the structural model.

Step 2: Structural model path coefficients of learners' measurement model

As recommended by Chin (1998), bootstrapping (with 5000 subsamples) was performed to test the statistical significance of each path coefficient using t-tests. Each path resembles each proposed hypothesis. The statistical significance, sign and size are used to test each hypothesis. The higher the path coefficient, the stronger the effect of the exogenous variable on the indigenous variable. The critical values for two-tailed t-tests used in this research are 1.65 (significance level= 10%); this was due to the exploratory nature of the study (Hair et al., 2014). Table 5.9 shows the results of the hypothesis tests.

Table 5.9: Results of direct hypotheses testing

Hypothesis No	Path relationship	Standard Beta	Standard Error	T-statistics	Decision	5.0%	95.0%
H1a	ATT -> BI	0.441	0.067	6.467**	Supported	0.323	0.545
H2d	PEC -> ATT	-0.131	0.056	2.274*	Supported	0.040	0.219
H4a	PEC-> PEOU	0.032	0.067	0.481	Not Supported	0.014	0.144
H3b	PEC -> PU	0.191	0.123	1.544	Not Supported	0.037	0.374
H4d	PEN -> PEOU	-0.184	0.063	2.916**	Supported	0.113	0.276
H1e	PEOU -> BI	0.152	0.062	2.374**	Supported	0.054	0.258
H3a	PEOU -> PU	0.355	0.100	3.300**	Supported	0.161	0.489
H2e	PPR -> ATT	0.057	0.068	0.833	Not Supported	0.055	0.171
H5b	PPR -> PSI	-0.104	0.063	1.653*	Supported	0.001	0.203
H2c	PR -> ATT	0.150	0.071	2.070**	Supported	0.036	0.268
H1d	PR -> BI	0.032	0.061	0.533	Not Supported	0.015	0.138
H4e	PR -> PEOU	0.175	0.083	2.148**	Supported	0.054	0.326
H3d	PR -> PU	0.092	0.073	1.255	Not Supported	0.022	0.219
H1b	PSI -> BI	0.145	0.074	1.972**	Supported	0.024	0.266
H3e	PSI -> PU	-0,084	0.097	0.862	Not Supported	-0,096	0.224
H4c	PSR -> PEOU	0.004	0.068	0.052	Not Supported	0.003	0.112
H5d	PSR -> PPR	0.629	0.067	9.433**	Supported	0.518	0.736
H2a	PU -> ATT	0.459	0.090	5.049**	Supported	0.299	0.591
H1c	PU -> BI	0.241	0.086	2.804**	Supported	0.089	0.372

** p<0.05; * P<0.1

Table 5.9 shows that out of nineteen hypotheses, only one was significant at 0.1 level, 11 were significant at 0.05 level and the remaining seven were insignificant. The hypotheses which were not supported by the data were H4a, H3b, H2e, H1d, H3d, H3e, and H4c. A summary of all significant path with their strength is shown in Table 5.10.

Table 5.10: Summary of path coefficient strength

Hypothesis No	Path relationship	Standard Beta	Strengths
H1a	ATT -> BI	0.441	Strong
H2d	PEC -> ATT	-0.131	Weak
H4d	PEN -> PEOU	-0.184	Weak
H1e	PEOU -> BI	0.152	Weak
H3a	PEOU -> PU	0.355	Moderate
H5c	PSI -> PPR	-0.104	Weak
H2c	PR -> ATT	0.150	Weak
H4e	PR -> PEOU	0.175	Weak
H1b	PSI -> BI	0.145	Weak
H5d	PSR -> PPR	0.629	Strong
H2a	PU -> ATT	0.459	Strong
H1c	PU -> BI	0.241	Weak

The results in Table 5.10 shows that three hypotheses were having negative beta values. The hypotheses with negative betas were H2d ($\beta = -0.131$, $p < 0.005$), H5c ($\beta = -0.104$, $p < 0.005$) , and H4d ($\beta = -0.184$, $p < 0.005$).The beta values of the hypotheses H1a ($\beta = 0.441$, $p < 0.005$), H5d ($\beta = 0.629$, $p < 0.005$), and H2a ($\beta = 0.459$, $p < 0.005$) are considered strong, the beta for H3a ($\beta = 0.355$, $p < 0.005$) is considered moderate while the beta values of all other hypotheses H1e ($\beta = 0.152$, $p < 0.005$), H2c ($\beta = 0.501$, $p < 0.005$), H4e ($\beta = 0.175$, $p < 0.005$), are considered weak (Pallani, 2010).

The indirect hypotheses were also tested. Table 5.11 shows the results of indirect hypotheses tests. The results in Table 5.11 were used to assess the indirect contributions of variables to the explained variance of behavioural intention. The results show that perceived resources had an indirect effect on behavioural intention (β = 0.080, p < 0.005) through the mediation of perceived attitude towards the use. The results on the table show that all the constructs on the model had a significant effect on behavioural intention. Perceived attitude towards the use, perceived social influence, perceived attitude towards and perceived ease of use had a direct effect on behavioural intention, while perceived resources had an indirect effect.

Table 5.11: Results of indirect hypotheses testing

Path relationship	Standard Beta	Standard Error	T-statistics	Decision	5.0%	95.0%
PEOU -> PU -> ATT	0.160	0.061	2.555**	Supported	0.060	0.259
PR -> PEOU -> PU -> ATT	0.032	0.021	1.317	Not supported	0.003	0.069
PR -> ATT -> BI	0.080	0.035	2.165**	Supported	0.022	0.130
PU -> ATT -> BI	0.192	0.046	4.179**	Supported	0.128	0.282
PEOU -> PU -> ATT -> BI	0.070	0.028	2.461**	Supported	0.028	0.117
PR -> PEOU -> PU -> ATT -> BI	0.014	0.009	1.321	Not supported	0.002	0.030
PR -> PEOU -> BI	0.032	0.023	1.185	Not supported	0.003	0.074
PEOU -> PU -> BI	0.083	0.040	2.132**	Supported	0.030	0.171
PR -> PEOU -> PU-> BI	0.016	0.012	1.269	Not supported	0.003	0.043
PR -> PEOU -> PU	0.072	0.043	1.480	Not supported	0.008	0.138

** $p<0.05$.

The results show that out of the 10 indirect hypotheses, five of them are significant at 0.05 level, while the other five were insignificant. It should be noted that all the significant indirect hypotheses were considered weak (Pallani, 2010).

Step 3 Coefficient of determination (R-squared)

The R-squared value shows the amount of variance in the endogenous variable that is explained by the exogenous variables. Additionally, the estimated variance explains the overall effect of the model via R-squared values or squares multiple correlations of dependent variables. Thus, the larger the R-squared value, the higher the predictive ability of the structural model. According to Falk and Miller (1992), the R-squared value should be more than 0.1. According to Chin (1998), a model having an R-squared of 0.67, 0.33, and 0.19 is considered as substantial, moderate, and weak, respectively.

After assessing the results of the bootstrapping procedure, all the paths which were not significant were removed from the model, as depicted in Figure 5.1. Additionally, hypotheses H2d (PEC -> ATT), H4d (PEN -> PEOU) and H5b (PPR -> PSI) were also removed from the model because there were negative significant betas. Removing hypothesis H5b lead to the removal of two constructs (perceived psychological readiness and perceived skills readiness), while removing H2d and H4d, led to the removal of perceived ease to collaborate and perceived enjoyment from the model. This meant that out of 10 constructs, only six remained. Figure 5.2 shows the learners' acceptance of mobile learning model's structural model. The learners' acceptance of mobile learning model's structural model shows that PR predicts PEOU and ATT, while PSI predicts BI only. PU is predicted by PEOU, while itself predicts ATT and BI. PEOU and ATT also predict BI.

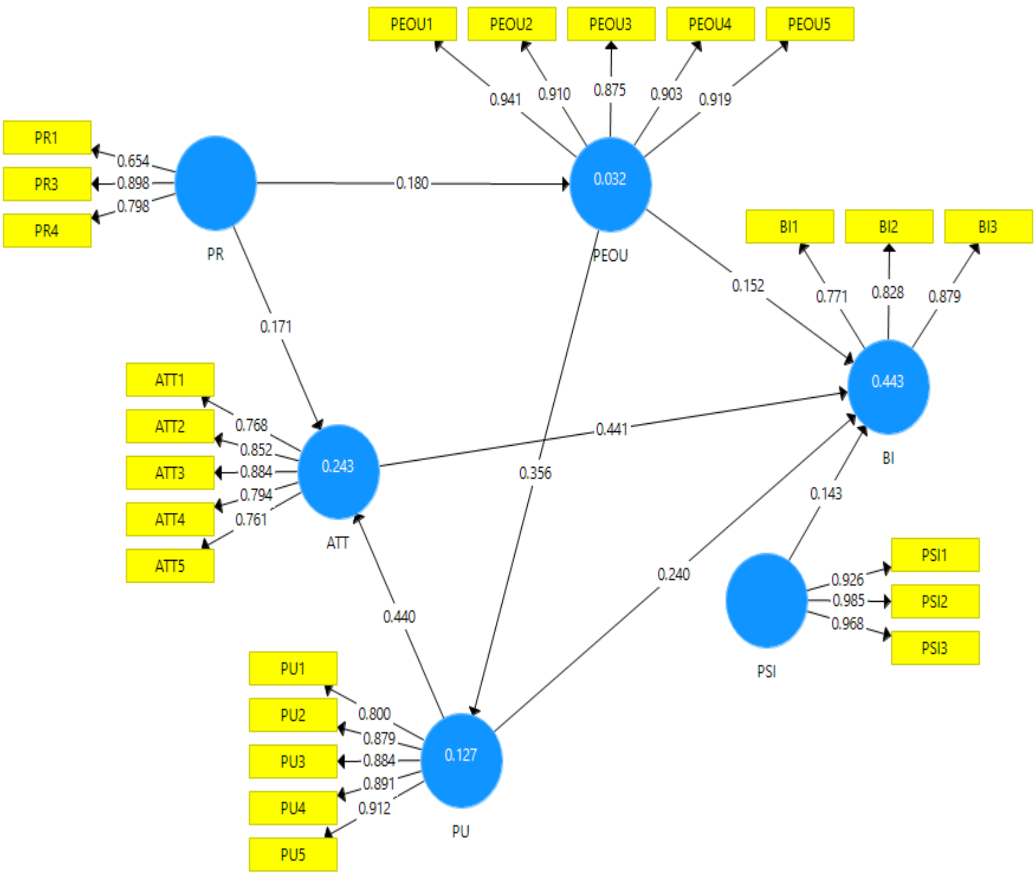


Figure 5.2: Learners' acceptance of mobile learning model's structural model

It can be seen from Figure 5.2 and Table 5.12 that 44.3% of the variance in learners' behavioural intention to use mobile learning for learning STEM-related subjects was explained by PU, PEOU, PSI, PR, and ATT. The variance explained in behavioural intention is considered moderate (Chin, 1998). The results were in line with the results of Venkatesh and Davis (2000), who found that the R-squared value of the extended Technology Acceptance Model ranges from 37% to 52%. PR and PU explained 24.3% of the variance in learners' perceived attitude towards the use of mobile learning for learning STEM-related subjects. The results also showed that the PR explained 3.2% of the variance in rural STEM learners' perceived ease of use. PEOU explained 12.7% of the variance in learners' perceived usefulness. Applying Chin's (1998) and Hock and Ringle's (2006) suggestions (section 4.7.5.3), the variance explained in BI and ATT were considered moderate, while the variance explained in PEOU and PU were below the minimum acceptable value of 19%.

Table 5.12: Coefficient determinations of learners' acceptance of mobile learning

	R-Square	R-Square adjusted
ATT	0.243	0.234
BI	0.443	0.430
PEOU	0.032	0.027
PU	0.127	0.121

Step 5 (a): Effect size (f-squared)

The summary and inference on the f-squared estimates for independent (exogenous) constructs across the model are shown in Table 5.13.

Table 5.13: Results of effect size (f-squared) analysis

Dependent construct	exogenous construct	R^2 Included	R^2 Excluded	f-squared
BI	PSI	0.443	0,268	0.31
	PU	0.443	0,253	0.34
	ATT	0.443	0,181	0.47
	PEOU	0.443	0,265	0.32
ATT	PU	0.243	0,030	0.28
	PR	0.243	0,130	0.15
PU	PEOU	0.127	0,000	0.15
PEOU	PR	0.032	0,000	0.03

The results show that of the four predictors (PSI, PU, ATT and PEOU) of behavioural intention to use mobile learning, perceived attitude towards had the strongest effect size. This implied that it was the predictor that contributed most to the explained variance of behavioural intention. Following the rules of thumb discussed in section 4.7.5.4 for the f-squared, the effect size of perceived attitude towards the use is considered large, while the effect size of perceived usefulness, perceived ease of use and perceived social influence can be considered moderate (Chin & Newsted, 1999; Hair et al., 2014). The results also showed that perceived usefulness contributed more than perceived resources to the R-squared value of perceived attitude towards. Both perceived usefulness and perceived resources had a moderate effect on perceived attitude towards' R-squared value. Perceived ease of use had a moderate effect on perceived usefulness, while perceived resources had a small effect on the R-squared of perceived ease of use (Chin & Newsted, 1999; Hair et al., 2014).

Step 5(b): Predictive relevance (Q-squared) of learners' acceptance of mobile learning

The Q-squared coefficient is a non-parametric Stone-Geisser test. Q-squared was used to assess the predictive validity (relevance) associated with each construct in the learners' acceptance of mobile model. This assessment can be done using jack-knife or blindfolding methods. In the current study, SmartPLS 3's blindfolding algorithm was used. The algorithm assessed by systematically assuming that every 7th case was missing from the responses, whereby the model parameters were then estimated and used to predict the missing values (Hair et al. 2014). Table 5.14 provides the Q-squared values (along with the R^2 values) of all the endogenous constructs. The Q-squared values were all above zero and therefore supported the model's predictive relevance regarding the endogenous latent variables (Hair et al, 2014).

Table 5.14: Results of predictive relevance (Q-squared)

Dependent construct	Independent construct	R^2 Included	R^2 Excluded	Q-squared
BI	PSI	0.278	0.268	0,02
	PU	0.278	0.253	0,03
	ATT	0.278	0.181	0,13
	PEOU	0.278	0.265	0,02
ATT	PU	0.146	0.030	0,14
	PR	0.146	0.130	0,02
PU	PEOU	0.086	0.000	0,09
PEOU	PR	0.022	0.000	002

5.5.2 Research Objective 2: Factors that Influence Rural High School STEM Teachers to Accept Mobile Learning

5.5.2.1 Teachers' Acceptance of Mobile Learning Model's Outer Model

To ascertain whether PU, PEOU, PR, PSI, PSR, PPR, ATT, PEC, PEN are good predictors of BI to use mobile learning, the partial least square based technique of SEM (PLS-SEM) was used in analysing the data. According to Hair et al. (2017) SEM (PLS-SEM) is a regression-based technique that minimizes the residual variances of the independent variable. A two-step approach recommended by Henseler et al.

(2009) was employed. In the first step, the teachers' acceptance of mobile learning model's outer model was evaluated to establish the relationship between the constructs and their items (Henseler, Hubona, & Ray, 2016). In the second step, the evaluation of the structural model which establishes the relationship among the latent variables (Tenenhaus, Vinzi, Chatelin, & Lauro, 2005). Assessing the measurement model involves assessing the reliability and validity of each latent variable to determine if it can be included in the inner model.

5.5.2.1.1 Reliability and Validity of Teachers' Acceptance of Mobile Learning Outer Model

To ascertain the degree of consistency of the various items of each latent variable, the reliability test was conducted. The composite reliability and the Cronbach alpha test were used to test for internal consistency. As shown in Table 5.15, only the Cronbach alpha coefficient of perceived resource was below the 0.70 recommended threshold (Nunnally, 1978). However, its composite reliability was 0.803, which was above the 0.70 recommended threshold (Hair et al., 2014). Due to the weakness of Cronbach's alpha test described in section 4.7.4.1.1, the composite reliability was preferred to Cronbach's alpha. Therefore, the items used had satisfactory internal consistency reliability as their composite reliability scores were all above the threshold value of 0.7. Furthermore, the AVE values were used to test for convergent validity. The rule of thumb for a valid latent variable is to have at least 50% of the total variance explained by the indicators within the construct (Hair et al., 2014). The AVE scores ranged from 0.510 to 0.886, an indication that convergent validity was assured.

Table 5.15: AVE, CR, Cronbach alpha

	Cronbach's alpha	Composite reliability	AVE
ATT	0.889	0.918	0.692
BI	0.830	0.898	0.746
PEOU	0.922	0.941	0.762
PPR	0.867	0.918	0.789
PR	0.676	0.803	0.510
PSI	0.937	0.959	0.886
PSR	0.814	0.890	0.730
PU	0.921	0.941	0.761

5.5.2.1.2 Indicator Reliability of Teachers' Acceptance of Mobile Learning Outer Model

Using SmartPLS 3 software, iterative evaluation of outer loadings was done based on the 0.70 rule of thumb (Hair et al., 2017). The indicators with outer loadings of less than 0.70 were removed one by one after each run. An indicator was removed only if its removal increased the composite reliability or the AVE values above their recommended cut-off values (Hair et al., 2014). This process was repeated until PR4 (0.618) and PR2 (0.590) were the only remaining items with loading below 0.70. These two indicators were returned because of their contribution to the content validity and also removing them did not increase the composite reliability or the AVE values above their cut-off values. The following indicators, however, were removed from the measurement model: PPR4, PEN1, PEN2, PEN3, PEC1, PEC2, and PEC3. Two construct PEN's and PEC's items were all removed in the process.

Table 5.16 shows the outer loadings of all the items used in the teachers' acceptance of mobile learning model's final outer model. Most of the items had outer loadings above 0.70, which implied that less than 50% of an item's variance was due to error. All the indicators presented an acceptable level of individual reliability.

Table 5.16: Indicators' outer loadings

Construct	Item	Loadings
Perceived attitude towards	ATT1	0.811
	ATT2	0.833
	ATT3	0.835
	ATT4	0.803
	ATT5	0.877
Behavioural intention	BI1	0.851
	BI2	0.886
	BI3	0.853
Perceived ease of use	PEOU1	0.863
	PEOU2	0.870
	PEOU3	0.886
	PEOU4	0.874
	PEOU5	0.871
Perceived psychological readiness	PPR1	0.886
	PPR2	0.871
	PPR3	0.907
Perceived resources	PR1	0.805
	PR2	0.590
	PR3	0.815
	PR4	0.618
Perceived social influence	PSI1	0.930
	PSI2	0.944
	PSI3	0.951
Perceived skills readiness	PSR1	0.874
	PSR2	0.802
	PSR3	0.886
Perceived usefulness	PU1	0.901
	PU2	0.826
	PU3	0.909
	PU4	0.880
	PU5	0.843

Items removed: indicator items were below 0.5: -PPR4, PEN1, PEN2, PEN3, PEC1, PEC2, PEC3

5.5.2.1.3 Validity of Teachers' Acceptance of Mobile Learning Outer Model

The Fornell-Larcker criterion was also used to assess the discriminant validity of the teachers' acceptance of m-learning outer model and the results are shown in Table 5.17. The bolded numbers in Table 5.17 represent the square roots of the AVE and the non-bolded values represent the intercorrelation value between latent variables. The results show that the square root of each latent variable's AVE was bigger than its highest correlation with any other latent variable (Fornell & Cha, 1994). Table 5.17 shows that none of the inter-construct correlation values were above the square-root of the AVE and satisfied the Fornel-Larcker criterion of the discriminant validity and indicated that all the constructs differed from each other.

Table 5.17: Fornell-Larcker criterion of teachers' acceptance of mobile learning outer model

	ATT	**BI**	**PEOU**	**PPR**	**PR**	**PSI**	**PSR**	**PU**
ATT	**0.832**							
BI	0.654	**0.863**						
PEOU	0.448	0.312	**0.873**					
PPR	0.103	0.066	0.161	**0.888**				
PR	0.550	0.311	0.381	0.042	**0.714**			
PSI	0.197	0.211	0.071	0.089	0.079	**0.941**		
PSR	0.055	0.000	0.037	0.363	0.029	0.088	**0.855**	
PU	0.367	0.332	0.199	0.098	0.201	0.096	0.051	**0.872**

Note: The square root of the AVE of each construct should be higher than its highest correlation with any other construct (Hair et al., 2014).

5.5.2.2 Structural Model Analysis

After establishing the suitability of the latent variables through the validity and reliability tests, the study evaluated the structural model to identify patterns in the data relationship. However, prior to this analysis, collinearity was assessed using the VIF. Variance inflation factor values were used to ascertain if the path coefficient to be estimated would be biased by multicollinearity problems. The results suggested that there were no collinearity issues, as VIF value ranged from 1.027 to 1.392. The VIF values were all below the threshold value of 5 (Hair et at., 2014). Table 5.18 shows the results of the collinearity test.

Table 5.18: Collinearity test of teachers' acceptance of mobile learning outer model

First set		Second set		Third set	
BI		ATT		PU	
Predictor	VIF value	Predictor	VIF value	Predictor	VIF value
ATT	1.392	PEOU	1.193	PPR	1.027
PEOU	1.254	PU	1.068	PR	1.171
PU	1.158	PR	1.196	PEOU	1.200
		PSI	1.014		

Based on this, the hypothesized relationships were analysed. As recommended (Chin, 1998), bootstrapping (with 5000 subsamples) was performed to test the statistical significance of each hypothesis using t-tests. The critical value for two-tailed t-tests used in this research was 1.65 (significance level = 10%); this was due to the exploratory nature of the study (Hair et al., 2014). Table 5.18 shows that out of 12 hypotheses, eight were significant and the remaining four were insignificant. The insignificant paths were removed from the final model. The final teachers' acceptance of mobile learning model's inner model is depicted in Figure 5.3. The model consists of six constructs (PU, PEOU, BI, ATT, PR, and PSI). ATT is the only prediction with a direct effect on BI, itself if directly influenced by PSI, PU and PEOU. PR predicts PU and PEOU.

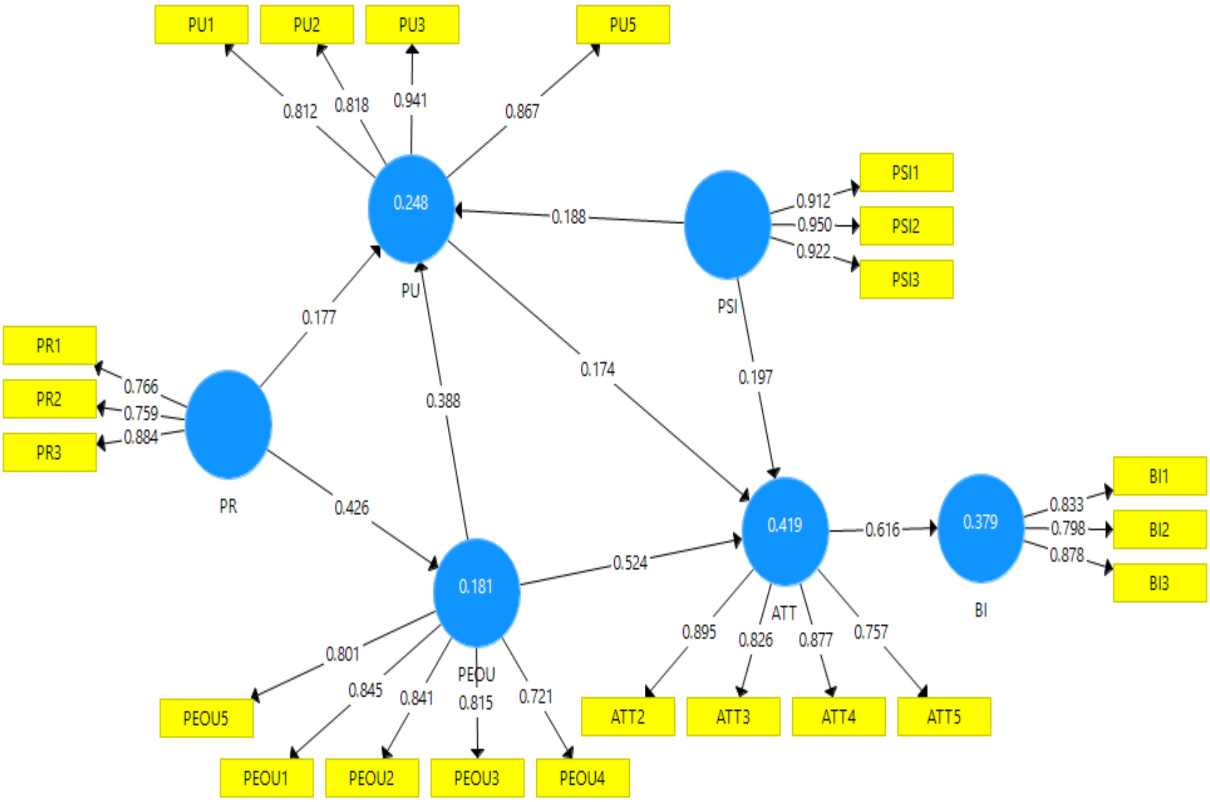


Figure 5.3: Teachers' acceptance of mobile learning model's structural model

Table 5.19 presents the results of the hypotheses test based on the bootstrapping analysis. An analysis of the p-values and path coefficients, as shown in Table 5.19, demonstrated that the study found support for eight out of the 12 hypothesized relationships. With an R-squared value of 37.9%, it can be concluded that approximately 38% of the variation in the behavioural intention to use M-learning was explained by the exogenous constructs. This means the combined effect of perceived ease of use, perceived attitude towards, perceived resources, perceived social influence and perceived resources on the explained variance in teachers' behavioural intention to use mobile learning is 37.9%. This explanatory power of the model is considered moderate (Chin, 1998).

Table 5.19: Regression output of teachers' acceptance of mobile learning

Hypotheses	Path	Standard Beta	T-statistics	P-values	Results
H1a	ATT -> BI	0,616	11,785	0,000	Accepted
H2b	PEOU -> ATT	0,524	4,476	0,000	Accepted
H1e	PEOU -> BI	0.019	0.189	0.850	Rejected
H3a	PEOU -> PU	0,388	3,984	0,000	Accepted
H4e	PR -> PEOU	0,426	4,764	0,000	Accepted
H3d	PR -> PU	0,177	1,859	0,064	Accepted
H2f	PSI -> ATT	0,197	2,784	0,006	Accepted
H3e	PSI -> PU	0,188	3,364	0,001	Accepted
H2a	PU -> ATT	0,174	1,974	0,049	Accepted
H1c	PU -> BI	0.105	0.934	0.351	Rejected
H2c	PR -> ATT	0.013	985	0.240	Rejected
H3c	PPR -> PU	0.130	1.372	0.171	Rejected

Figure 5.4 shows the resulting path coefficients of the suggested teachers' M-learning acceptance structural model. Generally, the data supported eight out of 12 hypotheses. Of the 12, six endogenous variables were verified in the model (ATT, PSI, PRBI, PU, and PEOU). Based on the data analysis hypotheses, H2b, H4e, H2a, H3a, H3d, H2f, H3e, and H1a were supported by the empirical data, while H2c, H1c, H3c, and H1e were rejected. The results showed that ATT significantly influenced BI (β= 0.616, p<0.000), supporting hypothesis H1a. PU significantly influenced ATT (β= 0.174, p<0.000) supporting hypothesis H2a. PR was determined to be significantly influenced PEOU (β= 0.426, p<0.000) and PU (β= 0.177, p<0.000) supporting hypothesis H4e and H3d respectively. PEOU had a significant effect on ATT (β= 0.524, p<0.000) and PU (β= 0.388, p<0.000) supporting hypotheses H2b and H3a, respectively. Furthermore, PSI influenced ATT (β= 0.197, p<0.000) and PU (β= 0.188, p<0.000), supporting H2f and H3e, respectively.

In contrast, the hypotheses H1e (β= 0.019, p<0.05), H3c (β= 0.130, p<0.05), H1c (β= 0.105, p<0.05) and H2c (β= 0.013, p<0.05) were statistically insignificant. Indirect hypotheses were also tested. Table 5.20 shows the result of significant indirect hypotheses.

Table 5.20: Results of indirect hypotheses testing of teachers' acceptance of mobile learning outer model

Path	Standard beta	Standard error	T-statistics	P-values
PR -> PEOU -> ATT	0.223	0.066	3.399	0.001
PEOU -> ATT -> BI	0.322	0.081	3.970	0.000
PR -> PEOU -> ATT -> BI	0.137	0.045	3.019	0.003
PSI -> ATT -> BI	0.121	0.045	2.681	0.008
PU -> ATT -> BI	0.107	0.058	1.859	0.064
PR -> PEOU -> PU	0.165	0.061	2.730	0.007

The results in Table 5.20 were used to assess the indirect contribution of perceived resources, perceived ease of use, perceived social influence and perceived usefulness of the explained variance of teachers' behavioural intention to use mobile learning. The results showed that perceived ease of use had a positive significant effect on behavioural intention ($\beta = 0.322$, $p < 0.05$) through the mediation of perceived attitude towards the use. Perceived attitude towards the use also mediated the relationship between perceived usefulness and behavioural intention to use mobile learning. The path showed that perceived usefulness positively affects behavioural intention ($\beta = 0.107$, $p < 0.05$) to use mobile learning. Behavioural intention was also indirectly influenced by perceived social influences ($\beta = 0.121$, $p < 0.05$). The relationship between perceived social influence and behavioural intention to use mobile learning was mediated by perceived attitude towards the use. Perceived resources influenced behavioural intention ($\beta = 0.137$, $p < 0.05$) to us mobile learning through the mediation of perceived ease of use and perceived attitude towards the use. The results in Table 5.20 show that all the exogenous variables (perceived resources, perceived ease of use, perceived social influence and perceived usefulness had an indirect impact on teachers' behavioural intention to use mobile learning.

Further, the predictive relevance of the model was assessed by adopting the blindfolding guidelines suggested by Hair et al. (2014). The rule of thumb is that the cross-validated redundancy (Q-squared) should be above zero to be considered relevant. Table 5.21 depicted the results that all the Q-squared values were greater than zero indicating the model predictive relevance.

Table 5.21: Q-squared and f-squared of teachers' acceptance of mobile learning outer model

Dependent construct	Independent construct	Q-squared	effects size
BI	ATT	0.11	0.44
ATT	PU	0,12	0.22
	PEOU	0,03	0.21
	PR	0,04	0.07
	PSI	0,01	0.07

Effect size measures of an independent latent variable have a substantial impact on a dependent latent variable. The results showed that perceived attitude had a large effect size (f-squared = 0.44) on behavioural intention. PU had a moderate effect size on both BI (f-squared =0.19) and ATT (f-squared = 0.22). These results mean that PU contributes more to the explained variance of perceived attitude towards than it does to the explained variance of behavioural intention to use. PEOU had a moderate effect size (f-squared =0.21) on ATT, while PR (f-squared = 0.07) and PSI (f-squared = 0.09) had a small effect size on ATT. These results mean removing PU on the model will affect the variance explained in perceived attitude towards the use, more than removing PEOU, PR and PSI. (Chin & Newsted, 1999; Hair et al., 2014). Essentially, PU contributes more to the explained variance of ATT than PEOU, PR and PSI. The results also showed that both PEOU (f-squared = 0.02) and PR (f-squared = 0.02) had a small effect size on PU. Perceived resources had a small effect size on perceived ease of use.

5.5.3 Research Objective 3: Factors that Influence Parents of Rural High School STEM Learners to Accept Mobile Learning

5.5.3.1 Parents' Acceptance of Mobile Learning Model's Outer Model Assessment

The SASTAM developed in Chapter 3 was assessed using a two-stage approach as recommended by many authors (Hair, Black, Babin, Anderson, & Tatham, 2006; Henseler, Christian & Sinkovics, 2009). Firstly, internal consistency reliability, indicator reliability, convergent validity, and discriminant validity were assessed to evaluate the quality of the outer model (Henseler et al., 2009; Hulland, 1999). The second stage assessed the structural model, following the five steps described in section 4.7.5. The following subsections present the results of the evaluation of parents' acceptance of mobile learning model's outer model and the inner model.

5.5.3.1.1 Internal Consistency Reliability of Parents' Acceptance of Mobile Learning Model

The composite reliability test was used to test for internal consistency. Composite reliability was preferred to Cronbach's alpha (CA), because of its ability to give more accurate results (Sánchez-Franco, 2006). According to Hair et al. (2014), each latent variable's composite reliability value should be greater or equal to 0.7. Table 5.22 shows that the composite reliability values of each latent variable for the parents' acceptance of mobile learning model ranged from 0.852 to 0.949. The results were also confirmed by the Cronbach's alpha test. The results show that the Cronbach's alpha values ranged from 0.748 to 0.920. The results indicated that the indicators used had acceptable internal consistency reliability as they were all above the cut-off value of 0.7.

Table 5.22: Internal consistent test of parents' acceptance of mobile learning model

Construct	Cronbach's Alpha	Composite Reliability
ATT	0.860	0.905
BI	0.790	0.875
PEOU	0.865	0.901
PPR	0.770	0.867
PR	0.748	0.852
PSI	0.920	0.949
PSR	0.823	0.894
PU	0.877	0.912

CR and CA should >0.7

5.5.3.1.2 Indicator Reliability of Parents' Acceptance of Mobile Learning Model

Indicator reliability shows which part of the indicator's variance can be explained by the underlying latent variable (Gotz, Liehr-Gobbers, & Krafft, 2010). According to Chin and Newsted (1999), a construct should explain a substantial amount of each item's variance, normally at least 50%. Hair et al. (2014) suggested a cut-off value for the outer loadings should be 0.7, which is slightly less than $\sqrt{(0.5)}$. Hair et al. (2014) stated that the items whose factor loadings are between 0.4 and 0.7 should be removed by carefully examining the effects of removing on the composite reliability and construct's content validity as described in section 4.7.4.1.2.

Using SmartPLS 3 software, iterative evaluation of outer loadings was done based on the 0.70 rule of thumb (Hair et al., 2014). The items with outer loading of lower than 0.70 were eliminated one by one after each run. An item was removed only if its removal increased the composite reliability or AVE above the suggested value (Hair et al., 2014). This process was repeated until only two indicators (PU2 with 0.651 and ATT4 with 0.664) with outer loadings below 0.70 remained.

The following indicators were removed during the process: PEOU4, PEOU5, PEC3, PSR3, PPR1, PPR2, PPR3, PPR4, PEN1, PEN2, and PEN3. Due to the removal of these indicators, perceived enjoyment and perceived psychological readiness were also removed from the parents' proposed model. Table 5.23 shows the outer loadings of all the indicators used in the parents' acceptance of mobile learning model's final outer model. Most of them have loadings greater than 0.70, which suggests that less than 50% of an item's variance was due to error. All the items presented an acceptable level of individual reliability.

Table 5.23: Outer loadings of parents' acceptance of mobile learning model

Construct	Item	Loading
Perceived skills readiness (PSR)	PSR1	0.878
	PSR2	0.871
	PSR3	0.828
Perceived social influence (PSI)	PSI1	0.913
	PSI2	0.950
	PSI3	0.922
Perceived psychological readiness (PPR)	PPR1	0.756
	PPR2	0.779
	PPR3	0.773
	PPR4	0.659
Perceived resource (PR)	PR1	0.766
	PR2	0.746
	PR3	0.838
	PR4	0.620
Perceived usefulness (PU)	PU1	0.749
	PU2	0.825
	PU3	0.931
	PU4	0.702
	PU5	0.882
Perceived attitude (ATT)	ATT1	0.691
	ATT2	0.884
	ATT3	0.803
	ATT4	0.870
Perceived ease of use (PEOU)	PEOU1	0.850
	PEOU2	0.856
	PEOU3	0.818
	PEOU4	0.705
	PEOU5	0.785
Behavioural intention (BI)	BI1	0.816
	BI2	0.801
	BI3	0.893

Items removed: indicator items were below 0.5: -PEOU4, PEOU5, PEC3, PSR3, PPR1, PPR2, PPR3, PPR4, PEN1, PEN2, PEN3

Factor loading should >0.7

5.5.3.1.3 Convergent Validity of Parents' Acceptance of Mobile Learning

The convergent validity of parents' acceptance of mobile learning model's outer model was assessed using the AVE (Fornell & Cha, 1994; Hair et al., 2014; Tabachnick & Fidell, 2007). According to Hair et al. (2014), for convergent validity to be established, the AVE value should be 0.5 or more. Table 5.24 shows that all the latent variables have AVE values ranging from 0.646 to 0.861, which surpassed the suggested cut-off value of 0.5.

Table 5.24: Average variance extracted (AVE) of parents' acceptance of mobile learning model

Construct	Average Variance Extracted (AVE)
ATT	0.706
BI	0.701
PEOU	0.647
PPR	0.686
PR	0.658
PSI	0.861
PSR	0.739
PU	0.676

The convergent validity of parents' acceptance of mobile learning model's outer model has been established, which indicates that the items of each latent variable share much in common, which is captured by the latent variable (Hair et al., 2014).

5.5.3.1.4 Discriminant Validity of Parents' Acceptance of Mobile Learning Model

Analysis of cross-loadings, Heterotrait-monotrait ratio (HTMT) and Fornell-Larcker criterion was used to assess discriminant validity as suggested by Chin (1998). The following subsection presents the results of the cross-loadings, HTMT and Fornell-Larcker criterion.

- **Analysis of cross-loadings**

A cross-loading assessment was carried out using SmartPLS 3 software. The output of the cross-loadings between the latent variables and items is shown in Table 5.25. Those denoted by the values in bold across constructs are its indicators. For example, perceived attitude toward the use (ATT) denoted by ATT1, ATT2, ATT3, and ATT4. had loadings (0.846, 0.775, 0839 and 0.664) which were higher than indicator variables such as ATT, PEC and PR in the same block. The results show that each item's outer loadings on the associated latent variable were bigger than all its loadings in other latent variables, and therefore demonstrated a discriminant validity of the latent variables.

Table 5.25: Cross-loading analysis of parents' model

	ATT	BI	PEC	PEOU	PR	PSI	PSR	PU
ATT1	**0.846**	0.548	0.486	0.536	0.468	0.579	0.326	0.496
ATT2	**0.775**	0.378	0.321	0.403	0.342	0.452	0.106	0.348
ATT3	**0.839**	0.576	0.315	0.521	0.504	0.560	0.358	0.411
ATT4	**0.664**	0.450	0.311	0.624	0.617	0.349	0.217	0.384
BI1	0.559	**0.855**	0.444	0.498	0.519	0.480	0.316	0.592
BI2	0.519	**0.861**	0.341	0.481	0.431	0.295	0.278	0.514
BI3	0.548	**0.866**	0.543	0.494	0.435	0.453	0.247	0.595
BI4	0.541	**0.840**	0.419	0.363	0.468	0.447	0.400	0.564
PEC1	0.421	0.471	**0.882**	0.280	0.349	0.394	0.203	0.599
PEC2	0.388	0.427	**0.873**	0.303	0.417	0.466	0.311	0.562
PEOU1	0.595	0.498	0.343	**0.866**	0.716	0.421	0.492	0.395
PEOU2	0.651	0.521	0.318	**0.893**	0.697	0.437	0.444	0.398
PEOU3	0.496	0.372	0.189	**0.866**	0.580	0.323	0.363	0.286
PR1	0.582	0.466	0.406	0.648	**0.914**	0.388	0.516	0.408
PR2	0.550	0.535	0.390	0.770	**0.913**	0.445	0.558	0.473
PR3	0.562	0.467	0.389	0.654	**0.889**	0.478	0.557	0.470
PSI1	0.573	0.393	0.299	0.422	0.391	**0.786**	0.255	0.510
PSI2	0.505	0.398	0.501	0.357	0.421	**0.871**	0.407	0.587
PSI3	0.408	0.386	0.373	0.305	0.339	**0.730**	0.282	0.482
PSR1	0.317	0.365	0.262	0.457	0.564	0.344	**0.919**	0.362
PSR2	0.303	0.305	0.276	0.468	0.546	0.386	**0.928**	0.404
PU1	0.303	0.547	0.410	0.322	0.290	0.456	0.309	**0.705**
PU2	0.431	0.341	0.601	0.282	0.345	0.397	0.248	**0.651**
PU3	0.236	0.379	0.466	0.180	0.205	0.470	0.234	**0.717**
PU4	0.414	0.553	0.475	0.384	0.423	0.442	0.309	**0.755**
PU5	0.441	0.582	0.425	0.317	0.421	0.544	0.387	**0.758**
PU6	0.449	0.464	0.529	0.313	0.447	0.569	0.305	**0.778**

- **Fornell-Larcker Criterion**

The correlation matrix for the latent variables is shown in Table 5.26. The bolded values in Table 5.26 represent the square roots of the AVE and values that are not bolded represent the intercorrelation value between latent variables. Based on the results shown in Table 5.26, all off-diagonal values are smaller than the square roots of AVE. The results show that the square root of each latent variable's AVE was better than its highest correlation with any other latent variable (Fornell & Cha, 1994). Therefore, the model satisfied the Fornell-Larcker criterion of the discriminant validity and showed that all the latent variables were distinct from each other.

Table 5.26: Fornell-Larcker criterion of parents' acceptance of mobile learning model

	ATT	BI	PEC	PEOU	PR	PSI	PSR	PU
ATT	**0.785**							
BI	0.634	**0.855**						
PEC	0.462	0.513	**0.877**					
PEOU	0.671	0.538	0.332	**0.875**				
PR	0.623	0.542	0.436	0.766	**0.905**			
PSI	0.626	0.491	0.489	0.456	0.483	**0.798**		
PSR	0.336	0.362	0.292	0.501	0.601	0.396	**0.924**	
PU	0.529	0.663	0.662	0.417	0.498	0.662	0.415	**0.729**

Table 5.27 shows the HTMT results.

Table 5.27: Heterotrait-monotrait ratio (HTMT) discriminant validity

	ATT	BI	PEC	PEN	PEOU	PPR	PR	PSI	PSR	PU
ATT										
BI	0.748									
PEC	0.126	0.211								
PEN	0.137	0.137	0.202							
PEOU	0.675	0.440	0.312	0.186						
PPR	0.129	0.109	0.231	0.555	0.186					
PR	0.288	0.192	0.422	0.200	0.527	0.123				
PSI	0.204	0.208	0.696	0.111	0.084	0.133	0.365			
PSR	0.134	0.134	0.188	0.382	0.084	0.785	0.098	0.106		
PU	0.480	0.401	0.248	0.207	0.476	0.118	0.367	0.118	0.074	

The HTMT values were less than 0.90, indicating acceptable discriminant validity. (Teo et al., 2008). Based on the results of HTMT, Fornell-Larcker criterion and the cross-loading, the parents' acceptance of mobile learning model's outer model presented an acceptable discriminant validity.

The parents' acceptance of mobile learning model's outer model has demonstrated satisfactory internal consistency reliability, indicator reliability, convergent validity, and discriminant validity. Therefore, parents' acceptance of mobile learning model's outer model established the ample robustness required to evaluate the inner model. Figure 5.4 depicts the parents' mobile learning acceptance measurement model showing factor loadings. The parents' mobile learning acceptance measurement model has eight constructs since PEN and PPR were removed because all their factor loadings were less than 0.7. The measurement model represents 20 hypotheses. These hypotheses were tested using the bootstrapping method. A total of three constructs (PR, PSR and PSI) are exogenous variables to endogenous variables (BI, ATT, PU, PEOU, and PEC), and (ATT, PU and PEOU) are also exogenous variables of BI.

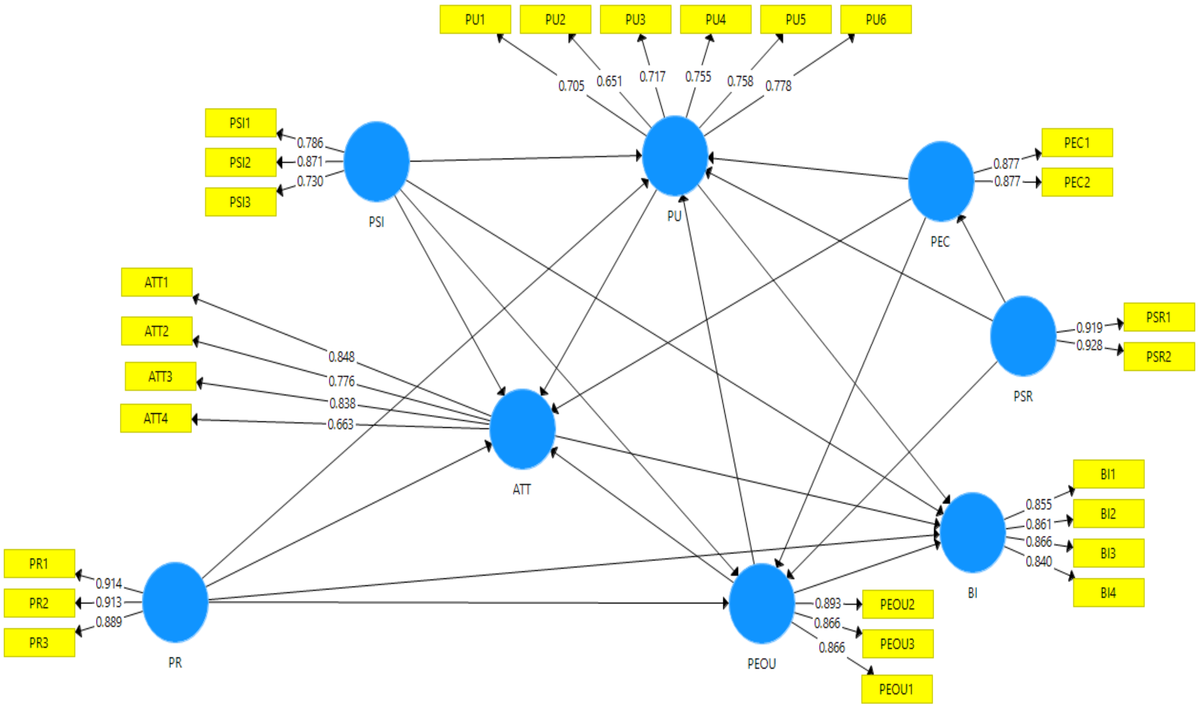


Figure 5.4: Parents' acceptance of mobile learning model's outer model

5.5.3.2 Parents' Acceptance of Model Learning Model's Inner Model Assessment

Once the reliability and validity of the latent variables were confirmed, the next step was to assess the parents' acceptance of mobile learning's inner model results. Section 5.7.2 provides insights into the evaluation of the parents' acceptance of mobile learning model's inner model. This section focuses on the results of the parents' acceptance of mobile learning model's inner model evaluation in five steps.

Step 1: Collinearity assessment

The VIF values were used to assess collinearity. The VIF value should be less than 5.00 in the predictor constructs (Hair et al., 2017). The following sets of predictor constructs for collinearity were assessed: (a) ATT, PEOU and PU as predictors of BI; (b) PEOU, PPR, PR and PSI as predictors of ATT; (c) PR, PPR, PSR and PSI as predictors of PEOU; and (d) PPR, PR and PSI as predictors of PU. Table 5.28 shows the results of the collinearity test. The range of all VIF values were from 1.007 to 1.639. All the VIF values of all predictors were lower than 5, demonstrating that collinearity among the predictors was not an issue in the inner model.

Table 5.28: Collinearity assessment of parents' acceptance of mobile learning model

First BI		Second set ATT		Third set PEOU		Fourth set PU	
Predictor	VIF value	Predictor	VIF value	Predictor	VIF value	Predictor	VIF value
ATT	1.634	PEOU	1.212	PPR	1.476	PPR	1.007
PEOU	1.639	PPR	1.007	PR	1.084	PR	1.082
PU	1.281	PR	1.305	PSI	1.093	PSI	1.089
		PSI	1.092	PSR	1.481		

Step 2: Structural model path coefficients

As recommended by (Chin, 1998), bootstrapping (with 5000 subsamples) was performed to test the statistical significance of each path coefficient using t-tests. The critical value for two-tailed tests used in this research was 1.65 (significance level = 10%); this was due to the exploratory nature of the study (Hair et al., 2014). Table 5.29 shows that out of 17 path relations, nine were significant and the remaining eight were insignificant. The non-significant paths were: PEOU to BI ($\beta = 0.013$, $p > 0.05$), PPR to ATT ($\beta = 0.045$, $p > 0.05$), PPR to PEOU ($\beta = 0.024$, $p > 0.05$), PPR to PU ($\beta = 0.050$, $p > 0.05$), PR to ATT ($\beta = 0.052$, $p > 0.05$), PSI to PEOU($\beta = 0.048$, $p > 0.05$), PU to BI ($\beta = 0.117$, $p > 0.05$), and PSR to PEOU ($\beta = 0.041$, $p > 0.05$).

Table 5.29: Results of direct hypotheses testing of parents' acceptance of mobile learning model

Path Relations	Standard Beta	Standard Error	T-statistics	Decision	5.0%	95.0%
ATT -> BI	0.560	0.086	6.519**	Supported	0.406	0.689
PEOU -> ATT	0.590	0.095	6.190**	Supported	0.403	0.722
PEOU -> BI	0.013	0.100	0.132	Not supported	0.008	0.182
PPR -> ATT	0.045	0.064	0.697	Not supported	0.035	0.158
PPR -> PEOU	0.024	0.092	0.261	Not supported	0.084	0.172
PPR -> PU	0.050	0.097	0.516	Not supported	0.103	0.219
PR -> ATT	0.052	0.092	0.565	Not supported	0.127	0.182
PR -> PEOU	0.428	0.096	4.461**	Supported	0.245	0.564
PR -> PU	0.383	0.090	4.274**	Supported	0.203	0.507
PSI -> ATT	0.239	0.066	3.625**	Supported	0.127	0.344
PSI -> PEOU	0.048	0.081	0.591	Not supported	0.101	0.166
PSI -> PR	0.275	0.077	3.557**	Supported	0.391	0.140
PSI -> PU	0.210	0.062	3.399**	Supported	0.102	0.306
PSR -> PEOU	0.041	0.093	0.442	Not supported	0.182	0.129
PSR -> PPR	0.567	0.074	7.682**	Supported	0.429	0.676
PU -> ATT	0.168	0.094	1.784	Supported	0.012	0.322
PU -> BI	0.117	0.104	1.124	Not supported	0.077	0.274

A summary of significant paths with their strength is shown in Table 5.30.

Table 5.30 Summary of significant paths and their strength

Path Relations	Standard Beta	Strength
ATT -> BI	0.560	Strong
PEOU -> ATT	0.590	Strong
PR -> PEOU	0.428	Strong
PR -> PU	0.383	Medium
PSI -> ATT	0.239	Weak
PSI -> PR	0.275	Weak
PSI -> PU	0.210	Weak
PSR -> PPR	0.567	Strong
PU-> ATT	0.168	Weak

Table 5.30 depicted that the relationship between perceived attitude and behavioural intention was supported (ATT->BI) ($\beta = 0.560$, $p < 0.05$). Next, the relationship between perceived ease of use and perceived attitude was supported ($\beta = 0.590$, $p < 0.05$). Perceived resources had a significant effect on perceived ease of use ($\beta = 0.428$, $p < 0.05$) and perceived usefulness ($\beta = 0.383$, $p < 0.05$). Perceived social influence had a significant effect on perceived usefulness ($\beta = 0.210$, $p < 0.05$), perceived resources ($\beta = 0.275$, $p < 0.05$) and perceived attitude towards ($\beta = 0.239$, $p < 0.05$). The relationship between perceived skills readiness and perceived psychological readiness was supported by ($\beta = 0.567$, $p < 0.05$). Path PU->ATT showed that perceived usefulness positively related with perceived attitude towards by ($\beta = 0.168$, $p < 0.05$).

Indirect hypotheses were also tested, and the results are displayed in Table 5.31

Table 5.31: Results of indirect hypotheses testing of parents' acceptance of mobile learning model

Path Relations	Standard Beta	Standard Error	T-statistics	Decision	5.0%	95.0%
PR -> PEOU -> ATT	0.228	0.071	3.220	Supported	0.113	0.343
PSI -> PR -> PEOU -> ATT	0.062	0.028	2.266	Supported	-0.118	-0.029
PR -> PEOU -> ATT -> BI	0.127	0.050	2.564	Supported	0.061	0.221
PSI -> PR -> PEOU -> ATT -> BI	0.035	0.018	1.957	Supported	-0.073	0.074
PEOU -> ATT -> BI	0.297	0.081	3.667	Supported	0.174	0.444
PSI -> ATT -> BI	0.115	0.042	2.730	Supported	0.049	0.186
PU -> ATT -> BI	0.094	0.056	1.675	Supported	0.010	0.193
PSI -> PR -> PEOU	0.117	0.048	2.462	Supported	-0.201	0,046
PSI -> PR -> PU	0.104	0.040	2.576	Supported	-0.177	0.046

The indirect hypotheses were used to assess the contribution of every construct on the model to the explained variance of behavioural intention. The results showed that the relationship between perceived resources and behavioural intention ($\beta = 0.127$, $p < 0.05$) was mediated by perceived attitude towards and perceived ease of use. Perceived social influence had a positive effect on behavioural intention ($\beta = 0.115$, $p < 0.05$) through the mediation of perceived attitude towards. The relationship between social influence and behavioural intention ($\beta = 0.035$, $p < 0.05$) was also mediated by perceived resources, perceived ease of use and perceived attitude towards. Perceived attitude towards mediated the relationship between perceived usefulness and behavioural intention ($\beta = 0.094$, $p < 0.05$). Perceived ease of use had a significant effect on behavioural intention ($\beta = 0.297$, $p < 0.05$) through the mediating effect of perceived attitude towards. The results in Table 5.30 show that all the constructs on the model were predictors of behavioural intention.

Figure 5.5 shows the parents' mobile learning acceptance model's structural model with path coefficient, outer loadings, and R-squared. The results in Table 5.29 show that all the paths from perceived psychological readiness (PPR to ATT, PPR to PU and PPR to PEOU) were not supported by the data, and as a result, the construct perceived psychological readiness was removed from the parents' mobile learning acceptance structural model. Perceived skills readiness was also removed from the model because the path perceived skills readiness to perceived ease of use was not supported by the data. Even though the path (perceived skills readiness to perceived psychological readiness) was supported by the data, the construct was removed because the only construct (perceived psychological readiness) that it was predicting was also removed from the final parents' acceptance of mobile learning model's structural model. Figure 5.5 shows that only perceived attitude towards had a direct effect on behavioural intention. Perceived resources predicted both perceived usefulness and perceived ease of use, while both (perceived usefulness and perceived ease of use) had a positive influence on perceived attitude towards. Perceived social influence also had a positive effect on perceived usefulness and perceived attitude towards.

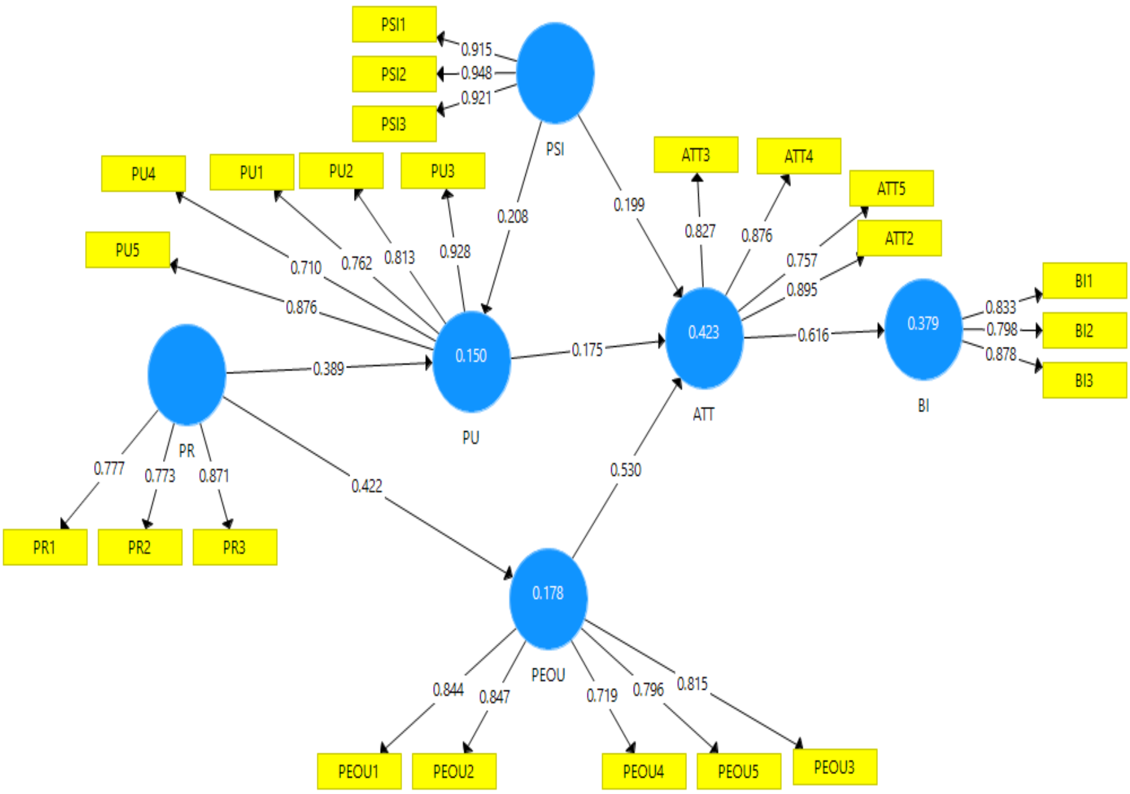


Figure 5.5: Parents' acceptance of mobile learning model's structural model

Step 3: Coefficient of determination (R-squared)

The R-squared value shows the amount of variance in endogenous variable that is explained by the exogenous variables (Hair et al., 2014). Thus, the higher the R-squared value, the higher the predictive ability of the inner model. According to Falk and Miller (1992), the R-squared value should be greater than 0.1. For this study, the bootstrapping procedure generated 5000 subsamples from 129 cases. Figure 5.5 shows the result of the parents' mobile learning acceptance model's structural model. Table 5.32 shows the R-squared values of the endogenous variables. The results showed that the R-squared values of perceived attitude towards and behavioural intention were 0.423 and 0.379 respectively; these R-squared were considered to be of moderate strength (Chin, 1998). In contrast, the R-squared values of perceived usefulness and perceived ease of use were 0.150 and 0.178 respectively and were considered weak (Chin, 1998). The total contribution of perceived ease of use, perceived usefulness, perceived social influence, perceived resources, and perceived attitude towards the explained variance of behavioural intention was 37.9%.

Table 5.32: Coefficient determinations of the construct of parents' acceptance of mobile learning model

	R-square	R-square adjusted
ATT	0.423	0.409
BI	0.379	0.374
PEOU	0.178	0.172
PU	0.150	0.137

Step 4: Effect size (f-squared)

The results of the f-squared estimate for exogenous latent variables across the model are displayed in Table 5.33.

Table 5.33: Results of effective size (f-squared) analysis of parents' acceptance of mobile learning model

Dependent construct	Independent construct	R^2 Included	R^2 Excluded	Effects size f^2
BI	ATT	0.379	0.154	0,36
ATT	PSI	0.423	0.384	0,07
	PU	0.423	0.398	0,04
	PEOU	0.423	0.195	0,40
PU	PSI	0.15	0.111	0,05
	PR	0.15	0.011	0,16

The results showed that of the three predictors (perceived social influence, perceived usefulness and perceived ease of use) of perceived attitudes towards the use of mobile learning, only perceived ease of use had a large effect size on perceived attitude towards' R-squared value (Cohen et al., 2003). Perceived social influence and perceived usefulness had a small effect size on the explained variance of perceived attitude towards (Cohen et al., 2003). This meant removing perceived ease of use from the model will affect the R-squared value of perceived attitude towards more than removing perceived social influence and perceived usefulness. Furthermore, it also meant that perceived ease of use predicted perceived attitude towards better than perceived usefulness and perceived social influence. Perceived attitude towards the use had a moderate effect on behavioural intention (Chin, 1998). Both perceived social influence and perceived resources had a small effect size on the R-squared value of perceived usefulness (Chin, 1998).

Step 5: Blindfolding and predictive relevance (Q-squared)

SmartPLS 3's blindfolding algorithm was used to calculate the Q-squared coefficient, which is a non-parametric Stone-Geisser test. Q-squared was used to evaluate the predictive relevance associated with each construct in the parents' acceptance of mobile learning model's structural model. The algorithm evaluated by systematically presumptuous that every 7th case was missing from the responses, whereby the model parameters were then estimated and used to predict the missing values (Hair et al., 2014). Table 5.34 presents the Q-squared values of all the dependent latent variables. All the Q-squared values were greater than zero and, therefore, indicating that parents' acceptance of mobile learning model can be used to predict and explain the acceptance of mobile learning by parents of rural high school STEM learners.

Table 5.34: Results of predictive relevance (Q-squared) of parents' acceptance of mobile learning model

Dependent construct	Independent construct	R^2 Included	R^2 Excluded	Q-squared
ATT	PU	0.261	0.248	0.02
	PEOU	0.261	0.121	0.19
	PSI	0.261	0.238	0.03
BI	ATT	0.241	0.12	0.16
PU	PSI	0.005	0.00	0.01

5.5.4 Research Objective 4: Is there a Significant Difference Between Learners' Attitudes and their Teachers' and Parents' Attitude Towards M-learning

5.5.4.1 Evaluation of the SASTAM's Measurement Model

SmartPLS 3 was used to evaluate the SASTAM's outer and inner models for this study. The SASTAM developed in Chapter 3 was assessed using a two-step approach as recommended by Hair et al. (2006) and Henseler et al. (2009). Step one, the SASTAM's outer model's adequacy, was assessed by looking at internal consistency reliability; indicator reliability; convergent validity and discriminant validity (Henseler et al., 2009; Hulland, 1999). Step two was to assess the outer model as described in section 4.7.5. The results of the analysis used to evaluate SASTAM's inner and outer models are discussed in the following subsections.

5.5.4.1.1 Internal Consistency Reliability of the SASTAM Model

The composite reliability values were used to assess for internal consistency reliability of SASTAM's outer model, as it gives more accurate results of internal consistency reliability than Cronbach's alpha test (Sánchez-Franco, 2006). According to Hair et al. (2014), each construct's composite reliability value should be greater or equal to 0.7. Table 5.34 shows that the consistency reliability of all latent variables in the SASTAM's outer model ranged from 0.776 to 0.966. The findings indicated that the indicators used had an acceptable internal consistency reliability as they were all having the composite reliability values above the threshold value of 0.7.

5.5.4.1.2 Indicator Reliability of the SASTAM Model

The indicator reliability indicates the amount an item's variance is explained by the underlying construct (Gotz et al., 2010). According to Chin and Newsted (1999), the construct should explain at least 50% of the variance in an indicator. Hair et al. (2014) recommended that a threshold value for the outer loadings should be 0.7, which is slightly less than $\sqrt{(0.5)}$. Hair et al. (2014) stated that the items whose factor loadings are between 0.4 and 0.7 should be removed by carefully examining the effects of removing them on the composite reliability and construct's content validity.

Using SmartPLS 3 software, iterative evaluation of outer loadings was conducted based on the 0.70 rule of thumb (Hair et al., 2014). The items with outer loading of lower than 0.70 were eliminated one by one after each run. An item was removed only if its removal increased the composite reliability value or the AVE value above the recommended cut-off value (Hair et al,.2014). This process was repeated until only three items (PR42 = 0.658 and PR2 =0.622) with loading below 0.70 remained. These items were returned due to their contribution to content validity. Additionally, removing these items did not change the composite reliability of their respective constructs. The items which were removed were PEC1, PEC2 and PEC3 and this led to the removal of perceived ease to collaborate as a construct from the model. Table 5.36 shows the outer loadings of all the items used in the SASTAM's final outer model. Almost all the items had outer loadings greater than 0.70, which implied that less than 50% of an item's variance was due to error. All the items presented an acceptable level of individual reliability.

5.5.4.1.2 Convergent Validity of the SASTAM Model

SASTAM's convergent validity was assessed using the AVE (Hair et al., 2017). According to Hair et al. (2014), the rule of thumb of convergent validity is an AVE value should be 0.5 or more. Table 5.35 shows that all latent variables had AVE ranging from 0.537 to 0.904, which surpassed the suggested cut-off value of 0.5. The SASTAM's measurement model demonstrated adequate convergent validity, which indicated that the measurement indicators of each construct had much in common, which was captured by the construct (Hair et al., 2014).

Table 5.35: SASTAM measurement model

Construct	Item	Loadings	Composite reliability	AVE
ATT	ATT1	0.754	0.907	0.663
	ATT2	0.854		
	ATT3	0.847		
	ATT4	0.818		
	ATT5	0.792		
BI	BI1	0.812	0.878	0.706
	BI2	0.836		
	BI3	0.872		
PEN	PEN1	0.762	0.776	0.537
	PEN2	0.726		
	PEN3	0.709		
PEOU	PEOU1	0.901	0.942	0.766
	PEOU2	0.886		
	PEOU3	0.865		
	PEOU4	0.846		
	PEOU5	0.877		
PPR	PPR1	0.843	0.904	0.758
	PPR2	0.873		
	PPR3	0.894		
PR	PR1	0.779	0.821	0.538
	PR2	0.622		
	PR3	0.852		
	PR4	0.658		
PSI	PSI1	0.937	0.966	0.904
	PSI2	0.963		
	PSI3	0.952		
PSR	PSR1	0.892	0.899	0.747
	PSR2	0.867		
	PSR3	0.833		
PU	PU1	0.811	0.932	0.734
	PU2	0.847		
	PU3	0.901		
	PU4	0.837		
	PU5	0.884		

5.5.4.1.3 Discriminant Validity of the SASTAM Model

Analysis of cross-loadings, AVE and HTMT were used to assess discriminant validity as suggested by Chin (1998). The results of these analyses are presented in the next following subsections.

- **Analysis of Cross-loadings**

The evaluation of the cross-loading was conducted using SmartPLS 3 software. The output of the cross-loadings between the latent variables and items is shown in Table 5.36. Those denoted by the values in bold across constructs are its indicators. For example, behavioural intention (BI) denoted by BI1, BI2 and BI3 had outer loadings (0.812, 0.836 and 0.872), which were higher than indicator variables such as ATT, PU and PEOU in the same block. The results showed that each item's outer loading on the associated latent variable was higher than all its loadings in other latent variables, and therefore demonstrated discriminant validity of the constructs.

Table 5.36: Cross-loading analysis of the SASTAM model

	ATT	BI	PEN	PEOU	PPR	PR	PSI	PSR	PU
ATT1	**0.754**	0.470	0.046	0.256	-0.004	0.201	0.087	-0.030	0.252
ATT2	**0.854**	0.482	-0.028	0.331	-0.012	0.271	0.051	0.000	0350
ATT3	**0.847**	0.542	-0.007	0.383	-0.028	0.305	0.025	-0.048	0.387
ATT4	**0.818**	0.495	-0.005	0.308	0.022	0.151	0.089	-0.008	0.410
ATT5	**0.792**	0.501	-0.046	0.267	0.058	0.241	0.055	0.054	0.304
BI1	0.546	**0.812**	-0.038	0.280	0.009	0.155	0.102	0.033	0.335
BI2	0.461	**0.836**	0.075	0.268	-0.031	0.163	0.119	-0.033	0.262
BI3	0.529	**0.872**	-0.054	0.282	-0.051	0.163	0.145	-0.087	0.423
PEN1	-0.042	-0.045	**0.762**	-0.085	0.266	-0.038	0.016	0.256	-0.058
PEN2	0.016	0.003	**0.726**	-0.079	0.164	0.022	0.069	0.164	-0.001
PEN3	0.023	0.040	**0.709**	-0.047	0.156	0.037	-0.005	0.146	0.013
PEOU1	0.361	0.306	-0.078	**0.901**	-0.054	0.252	-0.031	-0.024	0.272
PEOU2	0.377	0.307	-0.096	**0.886**	-0.055	0.241	-0.072	-0.013	0.279
PEOU3	0.333	0.277	-0.100	**0.865**	-0.060	0.291	-0.023	-0.047	0.261
PEOU4	0.310	0.276	-0.066	**0.846**	-0.056	0.222	-0.082	-0.006	0.313
PEOU5	0.288	0.277	-0.095	**0.877**	-0.094	0.207	-0.039	-0.025	0.296
PPR1	0.029	-0.002	0.310	-0.046	**0.843**	0.064	-0.072	0.477	0.088
PPR2	0.010	-0.040	0.141	-0.041	**0.873**	0.036	-0.074	0.494	0.061
PPR3	-0.021	-0.034	0.283	-0.104	**0.894**	-0.044	-0.031	0.443	0.047
PR1	0.235	0.174	-0.042	0.182	0.020	**0.779**	-0.108	0.015	0.132
PR2	0.088	0.032	0.005	0.170	-0.011	**0.622**	-0.083	-0.008	0.108
PR3	0.304	0.180	-0.005	0.244	0.004	**0.852**	-0.074	0.023	0.223
PR4	0.149	0.126	0.050	0.215	0.056	**0.658**	-0.089	0.056	0.073
PSI1	0.042	0.122	0.035	-0.075	-0.069	-0.124	**0.937**	-0.034	0.008
PSI2	0.068	0.147	0.037	-0.045	-0.074	-0.110	**0.963**	-0.059	0.029
PSI3	0.093	0.144	0.028	-0.043	-0.055	-0.100	**0.952**	-0.039	0.078
PSR1	0.021	-0.021	0.275	-0.006	0.488	0.031	-0.035	**0.892**	0.050
PSR2	0.005	-0.037	0.206	-0.007	0.493	0.038	-0.032	**0.867**	0.015
PSR3	-0.056	-0.031	0.226	-0.061	0.421	0.008	-0.053	**0.833**	0.015
PU1	0.390	0.335	0.018	0.298	0.002	0.131	0.076	0.010	**0.811**
PU2	0.322	0.334	-0.050	0.264	0.125	0.189	0.008	0.052	**0.847**
PU3	0.383	0.381	-0.020	0.294	0.082	0.148	0.043	0.032	**0.901**
PU4	0.342	0.330	-0.025	0.235	0.084	0.208	-0.002	0.035	**0.837**
PU5	0.369	0.374	-0.062	0.292	0.034	0.169	0.058	0.006	**0.884**

- **Analysis of Average Variance Extracted (AVE)**

The correlation matrix for the constructs is shown in Table 5.37. The bolded values in Table 5.37 represent the square roots of the AVE and non-bolded values represent the intercorrelation values between latent variables. All off-diagonal elements were less than square roots of AVE. The results showed that the square root of each latent variable's AVE was higher than its biggest correlation with any other latent variable (Fornell & Cha, 1994). Thus, the results satisfied the Fornell-Larcker criterion of the discriminant validity and indicated that the constructs were distinct from each other.

Table 5.37: Fornell-Larcker criterion of the SASTAM model

	ATT	BI	PEN	PEOU	PPR	PR	PSI	PSR	PU
ATT	**0,814**								
BI	0,613	**0,840**							
PEN	-0,011	-0,013	**0,733**						
PEOU	0,383	0,330	-0,099	**0,875**					
PPR	0,008	-0,029	0,283	-0,072	**0,870**				
PR	0,289	0,191	-0,002	0,278	0,023	**0,734**			
PSI	0,073	0,145	0,035	-0,057	-0,068	-0,116	**0,951**		
PSR	-0,009	-0,034	0,273	-0,026	0,543	0,031	-0,046	**0,865**	
PU	0,422	0,410	-0,032	0,324	0,076	0,196	0,044	0,031	**0,857**

Note: The square root of the AVE of each construct should be higher than its highest correlation with any other construct (Hair et al., 2014)

- **Heterotrait-monotrait Ratio (HTMT)**

The HTMT was also used to assess SASTAM's discriminant validity. Table 5.38 shows the HTMT results. All the HTMT values were less than 0.90, indicating that the constructs had an acceptable discriminant validity.

Table 5.38: The HTMT discriminant validity of the SASTAM model

	ATT	BI	PEN	PEOU	PPR	PR	PSI	PSR	PU
ATT									
BI	0,732								
PEN	0,074	0,106							
PEOU	0,421	0,385	0,126						
PPR	0,046	0,053	0,366	0,084					
PR	0,329	0,238	0,080	0,337	0,086				
PSI	0,084	0,167	0,055	0,061	0,077	0,146			
PSR	0,060	0,074	0,357	0,044	0,646	0,054	0,053		
PU	0,470	0,476	0,068	0,353	0,090	0,227	0,051	0,042	

Based on the results in sections 5.5.4.1.1 to 5.5.4.1.3, the SASTAM's measurement model presented satisfactory indicator reliability, convergent validity, and discriminant validity. Therefore, the SASTAM's outer model demonstrated the ample robustness needed to assess the SASTAM's structural model. Figure 5.6 depicts SASTAM's measurement model showing outer loadings. SASTAM's measurement model consists of nine constructs and 19 hypotheses to be tested. PSR and PEN are exogenous variables to PPR, while PPR, PEOU and PR are exogenous variables to PU. PSI, PR, PU, and PEOU are exogenous variables to ATT. PU, PEOU, and ATT are exogenous variables of the endogenous variable BI.

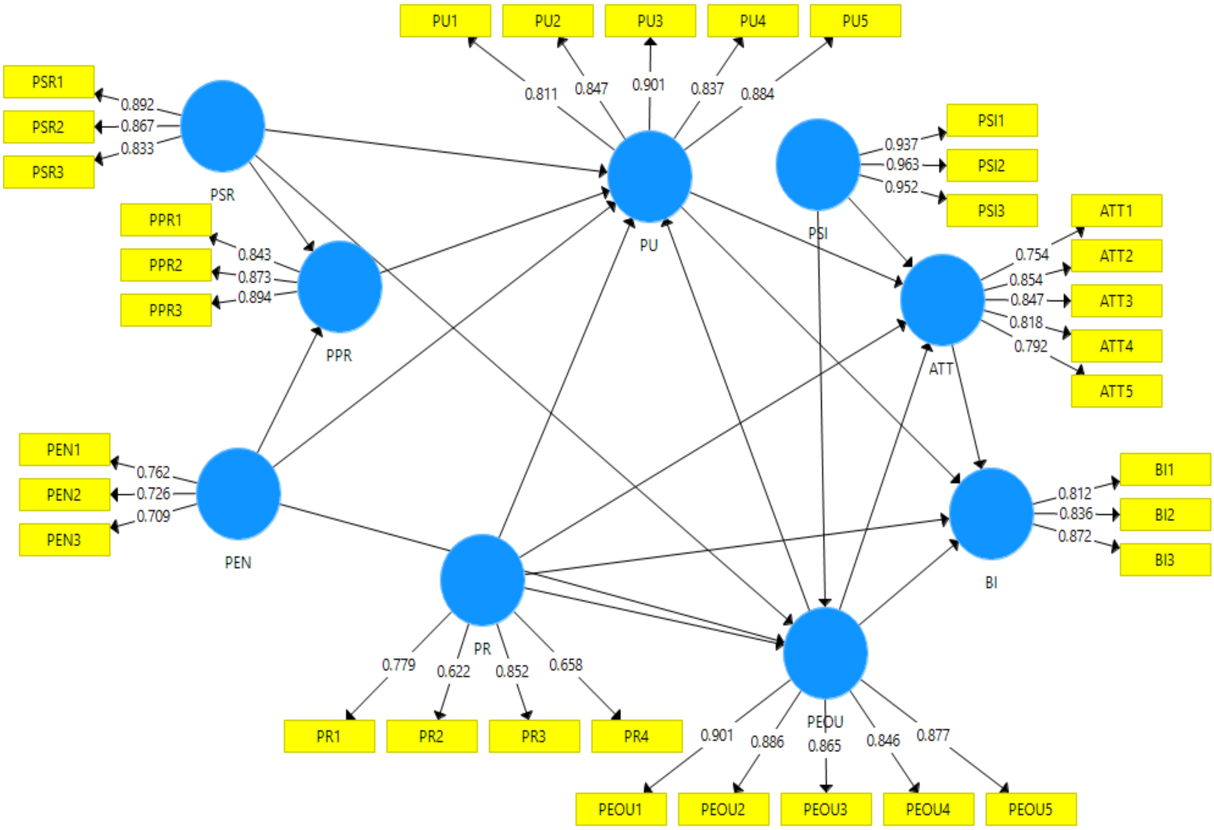


Figure 5.6: SASTAM's outer model

5.5.4.2 SASTAM's Structural Model Assessment

Once the construct measures were confirmed to be reliable and valid, the next step was to assess the SASTAM's structural model results. Section 5.5.4.2 provided insights into an evaluation of the SASTAM's structural model. This section focuses on the results of SASTAM's inner model assessment in five steps.

- **Step 1: Collinearity assessment**

The VIF values were used to assess collinearity. The VIF value should be less than 5.00 in the predictor constructs (Hair., 2017). The following sets of predictor constructs for collinearity were assessed: (a) ATT, PEOU and PU as predictors of BI; (b) PEOU, PU, PR and PSI as predictors of ATT; (c) PEN and PSR as predictors of PPR; and (d) PR, PPR and PEOU as predictors of PU. Table 5.39 shows the results of the collinearity test. All all VIF values ranged from 1.006 to 1.326. All the VIF values of all predictors were less than five, indicating that collinearity among the predictors was not an issue in the SASTAM's inner model.

Table 5.39: Collinearity assessment of the SASTAM model

First set BI		Second set ATT		Third set PPR		Fourth set PU	
Predictor	VIF value	Predictor	VIF value	Predictor	VIF value	Predictor	VIF value
ATT	1.326	PEOU	1.183	PSR	1.080	PEOU	1.093
PEOU	1.217	PU	1.144	PEN	1.080	PPR	1.006
PU	1.265	PR	1.121			PR	1.088
		PSI	1.023				

- **Step 2: Structural model path coefficients**

As recommended (Chin, 1998), bootstrapping (with 5000 subsamples) was performed to test the statistical significance of each path coefficient using t-tests. The critical value for two-tailed tests used in this research was 1.65 (significance level = 10%); this was due to the exploratory nature of the study (Hair et al., 2014). Table 5.40 shows that out of 19 path relations, five were not significant and the remaining 14 were significant. The hypotheses which were not significant were H3g ($\beta = -0.029$, $p > 0.05$), H1d ($\beta = -0.014$, $p > 0.05$), H4b ($\beta = -0.022$, $p > 0.05$), H4c ($\beta = -0.009$, $p > 0.05$), and H3f ($\beta = -0.017$, $p > 0.05$). The summary of all the significant paths is shown in Table 5.41.

Table 5.40: Results of direct hypotheses testing of the SASTAM model

Hypotheses	Path	Standard beta	Standard error	T-statistics	P-values	Decision
H1a	ATT -> BI	0,513	0,058	8,895	0,000	Accepted
H4d	PEN -> PEOU	-0,096	0,040	2,400	0,017	Accepted
H5c	PEN -> PPR	0,145	0,054	2,716	0,007	Accepted
H3g	PEN -> PU	-0,029	0,048	0,607	0,544	Rejected
H2b	PEOU -> ATT	0,241	0,055	4,396	0,000	Accepted
H1e	PEOU -> BI	0,083	0,045	1,822	0,069	Accepted
H3a	PEOU -> PU	0,298	0,062	4,767	0,000	Accepted
H3e	PPR -> PU	0,112	0,053	2,130	0,034	Accepted
H2c	PR -> ATT	0,173	0,050	3,490	0,001	Accepted
H1d	PR -> BI	-0,014	0,048	0,292	0,770	Rejected
H4e	PR -> PEOU	0,275	0,057	4,805	0,000	Accepted
H3d	PR -> PU	0,111	0,054	2,065	0,039	Accepted
H2f	PSI -> ATT	0,094	0,046	2,055	0,040	Accepted
H4b	PSI -> PEOU	-0,022	0,049	0,440	0,660	Rejected
H4c	PSR -> PEOU	-0,009	0,045	0,208	0,835	Rejected
H5d	PSR -> PPR	0,503	0,052	9,664	0,000	Accepted
H3f	PSR -> PU	-0,017	0,057	0,305	0,761	Rejected
H2a	PU -> ATT	0,306	0,054	5,645	0,000	Accepted
H1c	PU -> BI	0,170	0,057	2,979	0,003	Accepted

A summary of significant paths with their strength is shown in Table 5.41.

Table 5.41: Summary of significant paths and their strengths of the SASTAM model

Hypotheses	Path	std beta	Strength
H1a	ATT -> BI	0.513	Strong
H4d	PEN -> PEOU	-0.096	Weak
H5c	PEN -> PPR	0.145	Weak
H2b	PEOU -> ATT	0.241	Weak
H1e	PEOU -> BI	0.083	Weak
H3a	PEOU -> PU	0.298	Weak
H3e	PPR -> PU	0.112	Weak
H2c	PR -> ATT	0.173	Weak
H4e	PR -> PEOU	0.275	Weak
H3d	PR -> PU	0.111	Weak
H2f	PSI -> ATT	0.094	Weak
H5d	PSR -> PPR	0.503	Strong
H2a	PU -> ATT	0.306	Moderate
H1c	PU -> BI	0,170	Weak

Table 5.41 depicted that the relationship between perceived attitude towards the use and behavioural intention was supported H1a: ($\beta = 0.513$, $p < 0.05$). The data also supported the relationship between perceived skills readiness to perceived psychological readiness ($\beta = 0.503$, $p < 0.05$). Perceived enjoyment had a negative significant effect on perceive ease of use (H4d: ($\beta = -0.096$, $p < 0.05$)) and a positive significant effect on perceived psychological readiness (H5c: ($\beta = 0.145$, $p < 0.05$)). Perceived ease of use predicted all the original Technology Acceptance Model variables. Perceived ease of use had a positive significant effect on perceived attitude towards the use ($\beta = 0.241$, $p < 0.05$), perceived usefulness ($\beta = 0.298$, $p < 0.05$) and behavioural intention ($\beta = 0.083$, $p < 0.05$). Perceived usefulness was predicted by perceived psychological readiness ($\beta = 0.112$, $p < 0.05$), perceived ease of use (β =

0.298, $p < 0.05$), and perceived resources ($\beta = 0.111$, $p < 0.05$). Perceived attitude towards was predicted by perceived resources ($\beta = 0.173$, $p < 0.05$), perceived social influence ($\beta = 0.094$, $p < 0.05$), and perceived usefulness ($\beta = 0.306$, $p < 0.05$). Perceive resources had a significant effect on perceived ease of use ($\beta = 0.275$, $p < 0.05$). Finally, perceived usefulness predicted behavioural intention ($\beta = 0.170$, $p < 0.05$).

Before testing indirect hypotheses, all the paths which were not significant were removed from the SASTAM's structural model. Table 5.42 shows the results of indirect hypotheses testing.

Table 5.42: Results of indirect hypotheses testing of the SASTAM model

Path	Standard beta	Standard error	T-statistics	P-values	Decision
PEN -> PEOU -> ATT	-0,023	0,012	1,963	0,050	Accepted
PR -> PEOU -> ATT	0,066	0,024	2,710	0,007	Accepted
PEN -> PEOU -> PU -> ATT	-0,009	0,005	1,780	0,076	Accepted
PR -> PEOU -> PU -> ATT	0,025	0,009	2,788	0,005	Accepted
PEOU -> PU -> ATT	0,091	0,027	3,349	0,001	Accepted
PPR -> PU -> ATT	0,034	0,016	2,102	0,036	Accepted
PSR -> PPR -> PU -> ATT	0,017	0,009	2,014	0,045	Accepted
PR -> PU -> ATT	0,034	0,017	1,976	0,049	Accepted
PEN -> PEOU -> ATT -> BI	-0,012	0,006	1,976	0,049	Accepted
PR -> PEOU -> ATT -> BI	0,034	0,013	2,674	0,008	Accepted
PEOU -> ATT -> BI	0,124	0,030	4,122	0,000	Accepted
PR -> ATT -> BI	0,089	0,029	3,075	0,002	Accepted
PSI -> ATT -> BI	0,048	0,026	1,827	0,068	Accepted
PEN -> PEOU -> PU -> ATT -> BI	-0,004	0,002	1,823	0,069	Accepted
PR -> PEOU -> PU -> ATT -> BI	0,013	0,005	2,856	0,004	Accepted
PEOU -> PU -> ATT -> BI	0,047	0,014	3,418	0,001	Accepted
PPR -> PU -> ATT -> BI	0,018	0,008	2,119	0,035	Accepted
PSR -> PPR -> PU -> ATT -> BI	0,009	0,004	2,021	0,044	Accepted
PR -> PU -> ATT -> BI	0,018	0,009	1,921	0,055	Accepted
PU -> ATT -> BI	0,157	0,031	5,072	0,000	Accepted
PR -> PEOU -> PU -> BI	0,014	0,007	1,934	0,054	Accepted
PEOU -> PU -> BI	0,050	0,023	2,226	0,026	Accepted
PPR -> PU -> BI	0,019	0,011	1,722	0,086	Accepted
PSR -> PPR -> PU -> BI	0,010	0,006	1,650	0,100	Accepted
PR -> PU -> BI	0,019	0,011	1,777	0,076	Accepted
PEN -> PEOU -> PU	-0,028	0,014	2,005	0,046	Accepted
PR -> PEOU -> PU	0,082	0,026	3,156	0,002	Accepted
PSR -> PPR -> PU	0,056	0,028	2,018	0,044	Accepted

The results of indirect hypotheses testing were used to assess the contribution of each construct to the explained variance of behavioural intention to use mobile learning. The results showed that perceived enjoyments indirectly influence behavioural intention through perceived ease of use and perceived attitudes towards and also through perceived ease of use, perceived usefulness, and perceived attitude towards. However, in both indirect paths perceived enjoyment had a negative effect on behavioural intention of (β = -0.004, $p < 0.05$) and (β = -0.012, $p < 0.05$). These results indicate that perceived enjoyment was not a factor that rural high school STEM learners consider important when accepting mobile learning. Due to the negative contribution of perceived enjoyment to the behavioural intention to use mobile learning, perceived enjoyment was removed from the model.

The results also show that perceived resources predicted behavioural intention (β = 0.019, $p < 0.05$) through the mediation of perceived usefulness. Perceived skills readiness predicted behavioural intention (β = 0.010, $p < 0.05$) through the mediating effect of perceived psychological readiness and perceived usefulness. The relationship between perceived psychological readiness and behavioural intention (β = 0.019, $p < 0.05$) was mediated by perceived usefulness. Perceived attitude towards mediate the relationship between perceived ease of use and behavioural intention (β = 0.124, $p < 0.05$). Perceived social influence predicted behavioural intention (β = 0.048, $p < 0.05$) through perceived attitude towards. The relationship between perceived resources and behavioural intention was mediated by perceived attitude towards the use (β = 0. 089, $p < 0.05$). The results in Table 5.42 show that all the constructs on the SASTAM model contributed to the explained variance of behavioural intention. In other words, the factors on the SASTAM model influence rural high school STEM learners, their teachers, and learners' behavioural intention to use mobile learning.

The SASTAM inner model is shown in Figure 5.7. The model shows the R-squared, path coefficient and outer loadings. The results show that PEN and PSR predict PPR, and they both explained 31.4% of the variance in perceived psychological readiness. The results also show that PEOU, PR and PPR are predictors of PU, and explained 12.6% of the variance in PU. The variance explained in ATT by its predictors (PSI, PR, PEOU, and PU) was 27.8%. Additionally, the results also show that PU, ATT, and PU were predictors of BI. The results showed that the SASTAM model had an explanatory power of 40.8%. This explanatory power was considered moderate (Chin, 1998).

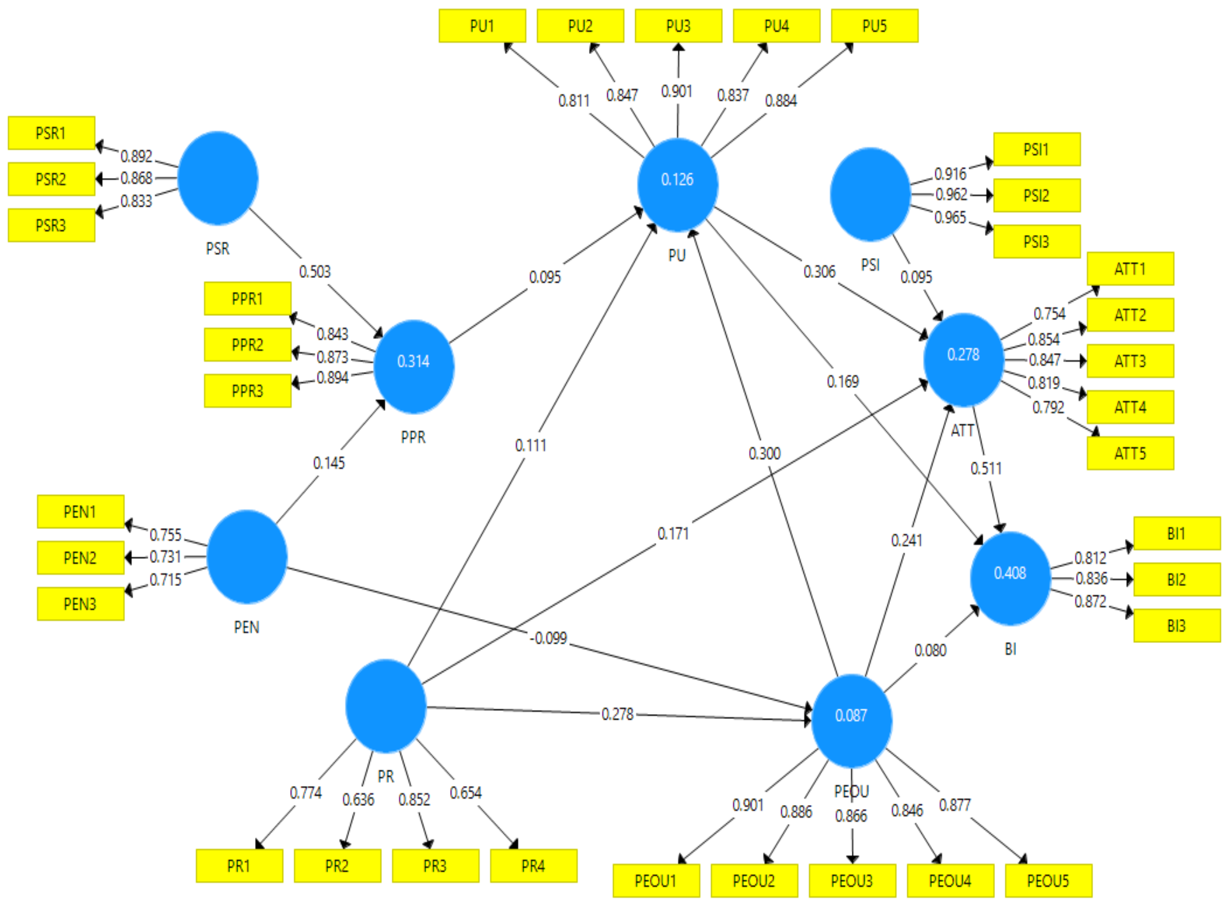


Figure 5.7: SASTAM's inner model with path coefficient and outer loadings

- **Step 3 Coefficient of Determination (R-squared)**

The R-squared value shows the amount of variance in an endogenous variable that is explained by the exogenous variables. Thus, the higher the R-squared value, the higher the predictive ability of the inner model. According to Falk and Miller (1992), the R-squared value should be at least 0.1 or more. According to Chin (1998), a model having an R-squared value as 0.67, 0.33, and 0.19 is considered as substantial, moderate, and weak, respectively. Figure 5.7 and Table 5.43 show the results of the SASTAM's structural model. The results showed that the R-squared values of PPR and BI were 0.314 and 0.408 respectively; these R-squared values are considered to be of moderate strength. In contrast, the R-squared of PU, ATT and PEOU were 0.126, 0.278 and 0.077, respectively. According to Chin (1998), these R-squared values are considered weak.

Table 5.43: Coefficient determinations of the construct of the SASTAM model

	R-square	R-square adjusted
ATT	0.278	0.274
BI	0.408	0.404
PEOU	0.077	0.070
PPR	0.314	0.311
PU	0.126	0.120

- **Step 4: Effect size (f-squared)**

The f-squared estimate for exogenous latent variables across the model are shown in Table 5.44.

Table 5.44: Results of effective size (f-squared) analysis of the SASTAM model

Dependent construct	Independent construct	R-squared Included	R-squared Excluded	Effects size
BI	ATT	0.408	0.149	0.440
	PU	0.408	0.254	0.260
	PEOU	0408	0.264	0.243
ATT	PU	0.278	0.122	0.216
	PR	0.278	0.154	0.171
	PEOU	0.278	0.142	0.188
PEOU	PR	0.077	0.000	0.083
PU	PPR	0.128	0.081	0.054
	PR	0.128	0.077	0.058
	PEOU	0.128	0.033	0.108
PPR	PEN	0.314	0.208	0.154
	PSR	0.314	0.057	0.375

The f-squared measures of an exogenous variable have a substantial influence on an indigenous variable. The results showed that perceived attitude has a high effect size (f-squared = 0.4) on BI (Cohen et al., 2003). This means that ATT had a bigger contribution to the R-squared value of BI. PU and PEOU have a medium effect size on BI. PU, PR and PEOU have a medium effect size on ATT. PPR, PR and PEOU have small effect sizes on PU. PEN has a medium effect on PPR while PSR has a high effect on PPR.

- **Step 5: Blindfolding and Predictive Relevance Q-squared**

The Q-squared coefficient is a non-parametric Stone-Geisser test. Q-squared was used to evaluate the predictive validity associated with each construct in the SASTAM. This was done using SmartPLS 3's blindfolding algorithm. The algorithm assessed by systematically assuming that every 7th case was missing from the responses, whereby the model parameters were then estimated and used to predict the missing values (Hair et al., 2014). Table 5.45 provides the Q-squared values of all the dependent constructs. All the Q-squared values were greater zero, indicating that SASTAM can be used to predict rural high school STEM learners', their teachers', and parents' behavioural intention to use mobile learning (Hair et al., 2014).

Table 5.45: Results of predictive relevance (Q-squared) of the SASTAM model

Dependent construct	Independent construct	R-squared included	R-squared excluded	Q-squared
BI	ATT	0.267	0.149	0.161
	PU	0.267	0.254	0.018
	PEOU	0.267	0.264	0.004
ATT	PU	0.170	0.122	0.058
	PR	0.170	0.154	0.019
	PEOU	0.170	0.142	0.034
PEOU	PR	0.054	0.000	0.057
PU	PPR	0.086	0.081	0.005
	PR	0.086	0.077	0.010
	PEOU	0.083	0.033	0.055
PPR	PEN	0.220	0.208	0.015
	PSR	0.220	0.057	0.209

5.5.4.3 Multigroup analysis

Multigroup analysis was used to assess if there was a significant difference between the path coefficients of SASTAM's learners' and parents' outer models. Table 5.46 shows the results of the Welch-Satterthwait test and Table 5.47 shows the results of the parametric test.

Table 5.46: Welch-Satterthwait test of the SASTAM model

Path	Path coefficients-diff (|leaners - parents |)	t-Value (leaners vs parents)	p-Value (leaners vs parents)
ATT -> BI	0.157	1.399	0.164
PEN -> PPR	0.098	0.904	0.367
PEOU -> ATT	0.440	3.264**	0.001
PEOU -> BI	0.149	1.254	0.212
PEOU -> PU	0.020	0.142	0.888
PPR -> PU	0.076	0.698	0.487
PR -> ATT	0.114	1.006	0.316
PR -> PEOU	0.261	2.204**	0.029
PR -> PU	0.075	0.579	0.564
PSI -> ATT	0.278	3.115**	0.002
PSR -> PPR	0.008	0.073	0.942
PU -> ATT	0.236	1.891	0.061
PU -> BI	0.137	1.030	0.305

** p<0.05; *p< 0.1

The results show than only three paths, PEOU to ATT, PR to PEOU and PSI to ATT are statistically significant. The results were also confirmed by the parametric test results in Table 5.47.

Table 5.47: The parametric test (learners-parents)

Path	Path coefficients-diff (| leaners - parents |)	t-value (leaners vs parents)	p-value (leaners vs parents)
ATT -> BI	0.157	1.419	0.157
PEN -> PPR	0.098	0.878	0.381
PEOU -> ATT	0.440	3.303**	0.001
PEOU -> BI	0.149	1.320	0.188
PEOU -> PU	0.020	0.138	0.890
PPR -> PU	0.076	0.690	0.491
PR -> ATT	0.114	0.995	0.321
PR -> PEOU	0.261	2.155**	0.032
PR -> PU	0.075	0.586	0.559
PSI -> ATT	0.278	3.131**	0.002
PSR -> PPR	0.008	0.072	0.943
PU -> ATT	0.236	1.854	0.065
PU -> BI	0.137	1.033	0.302

** $p<0.05$

Based on the results in Table 5.46 and Table 5.47, the results showed that learners' path coefficients were higher than their parents'. The results also revealed that for the paths PEOU to ATT, PR to PEOU and PSI to ATT learners' path coefficients are higher and statistically different from their parents'. However, the difference is not significant for the following paths: PU to BI, PSR to PPR, PR to PU, PR to ATT, PPR to PU, PEOU to PU, PEOU to BI, PEN to PPR and ATT to BI.

Multigroup analysis was also used to assess if there was a significant difference between learners' model and teachers' model path coefficients. Table 5.48 and Table 5.49 shows the results.

Table 5.48: The parametric test (learners-teachers)

	Path coefficients-diff (| leaners - teachers |)	t-value (leaners vs teachers)	p-value (leaners vs teachers)
ATT -> BI	0.179	1.387	0.167
PEN -> PPR	0.009	0.067	0.947
PEOU -> ATT	0.150	1.201	0.231
PEOU -> BI	0.120	1.101	0.272
PEOU -> PU	0.183	1.172	0.242
PPR -> PU	0.022	0.185	0.854
PR -> ATT	0.274	2.115*	0.035
PR -> PEOU	0.203	1.589	0.113
PR -> PU	0.068	0.482	0.630
PSI -> ATT	0.198	1.955	0.052
PSR -> PPR	0.217	1.554	0.121
PU -> ATT	0.186	1.429	0.154
PU -> BI	0.148	1.072	0.285

Table 5.49: Welch- Satterthwait test (learners-teachers)

Path	Path coefficients-diff (| leaners - teachers |)	t-value (leaners vs teachers)	p-value (leaners vs teachers)
ATT -> BI	0.179	1.291	0.199
PEN -> PPR	0.009	0.065	0.949
PEOU -> ATT	0.150	1.242	0.216
PEOU -> BI	0.120	1.049	0.296
PEOU -> PU	0.183	1.190	0.236
PPR -> PU	0.022	0.185	0.853
PR -> ATT	0.274	2.082*	0.039
PR -> PEOU	0.203	1.613	0.109
PR -> PU	0.068	0.464	0.643
PSI -> ATT	0.198	1.873	0.063
PSR -> PPR	0.217	1.467	0.145
PU -> ATT	0.186	1.507	0.134
PU -> BI	0.148	1.065	0.289

The results of both tests show that learners have a higher path coefficient than their teachers, however, the difference is not statistically significant for the following paths: ATT to BI, PEN to PPR, PEOU to ATT, PEOU to BI. PEOU to PU, PPR to PU, PR to PEOU, PR to PU, PSI to ATT, PSR to PPR, PU to ATT to PU, and PU to BI. In contrast, learners' path coefficient for PR to ATT is high and significantly different from their teachers.

To assess if there was a significant difference between parents' model and teachers' model path coefficients, the multigroup analysis was also used to. Table 5.50 shows the Welch- Satterthwait test results.

Table 5.50: Welch- Satterthwait test

Path	Path Coefficients-diff (| Teachers - parents |)	t-Value (TEACHERS vs PARENTS)	p-Value (Teachers vs Parents)
ATT -> BI	0.022	0.144	0.885
PEN -> PEOU	0.220	1.418	0.158
PEN -> PPR	0.095	0.669	0.504
PEOU -> ATT	0.281	1.985	0.048
PEOU -> BI	0.029	0.210	0.834
PEOU -> PU	0.192	1.305	0.193
PPR -> PU	0.098	0.821	0.412
PR -> ATT	0.364	2.732	0.007
PR -> PEOU	0.052	0.448	0.655
PR -> PU	0.040	0.256	0.798
PSI -> ATT	0.087	0.764	0.446
PSR -> PPR	0.209	1.485	0.139
PU -> ATT	0.065	0.524	0.601
PU -> BI	0.012	0.075	0.940

The Welch- Satterthwait test results showed that teachers' path coefficients were higher than parents'. The results also revealed that for the paths PEOU to ATT and PR to ATT teachers' path coefficients were higher and statistically different from the parents'. However, the difference is not significant for the following paths: PU to BI, PU to ATT, PSR to PPR, PR to PU, PR to PEOU, PPR to PU, PEOU to BI, PEN to PEOU, PEOU to PU, PEN to PPR, and ATT to BI.

5.6 Summary

The chapter presented how data was first prepared prior to analysis. The editing of the data collected was done using the Statistical Package for Social Sciences (SPSS). Data screening was performed by examining any missing data and outliers and normality tests. Once data preparation was completed, SmartPLS 3 was then used to perform data analysis. This analysis was done in two stages. In the first stage, the measurement models were assessed on internal consistency reliability, indicator reliability, discriminant validity, and convergent validity. With acceptable results for reliability and validity, the analysis of the measurement models was done to test the research hypotheses of this study and to determine the explanatory power of the proposed models.

CHAPTER 6 QUALITATIVE ANALYSIS

6.1 Introduction and Presentation of the Findings

The participants of the interviews were rural high school STEM learners, their teachers, and parents who were part of Phase One (questionnaire) respondents, and who had then offered to be interviewed. A total of 12 participants were interviewed. Of this number, six of the participants were learners, three were teachers and the other three were parents. The group interviews were conducted separately on different days. They were conducted in Head of Mathematics and Sciences Department's offices. The interviews were conducted after working hours as it was convenient for the participants. The participants were given the interview schedule before the interview, and the researchers' contact details in case they had some questions. The participants preferred the researcher to take notes rather than tape recording them.

The narrative form was used to present the collected data in this section. The interview schedule used was a semi-structured interview with open-ended questions. Thematic analysis, as explained in section 4.8.4, was utilized to analyse the data. The data collected were properly reduced so that the researcher could easily extract the key points that could be used to answer the research questions and to explain the factors that influence rural high school STEM learners, their parents, and teachers in the acceptance of mobile learning in South Africa. A research scholar created summary sheets for the three group interviews which were carried out to see which points each group highlighted relating to the constructs of SASTAM.

All interviewees were allocated a number (for example, P1 - P6 for learners) so that they would remain anonymous. The responses to the questions were written under the questions; in cases where the answer appeared to pertain to other constructs, it was noted.

The purpose of the interviews was to provide answers to the following question:

- What are the factors that rural high school STEM learners, their teachers, and parents consider important when accepting M-learning?

The question was divided into the following sub-questions.

- Why does perceived attitude towards the use, perceived social influence, perceived usefulness, and perceived resources explain variances in behavioural intention to use M-learning?
- Why does perceived usefulness, perceived psychological readiness, perceived social influence, perceived ease of use, and perceived resources explain variances in the perceived attitude towards the use of M-learning?
- Why does perceived ease of use, perceived social influence, perceived psychological readiness, perceived resources, and perceived skills readiness explain variances in the perceived usefulness of M-learning?
- Why does perceived psychological readiness, perceived resources, perceived social influence, perceived skills readiness, and perceived enjoyment explain variances in the perceived ease of use of M-learning?
- Why do perceived resources, perceived social influence, and perceived enjoyment explain variances in the perceived psychological readiness of M-learning?

The sub-questions were coded (see Table 6.1) and the interviews structured accordingly (for the interview schedule, see Appendix 6).

Table 6.1: Codes and categories

Code	Categories
BI	Perceived attitude towards the use
	Perceived social influence
	Perceived usefulness
	Perceived resources
ATT	Perceived usefulness
	Perceived easy to collaborate
	Perceived psychological readiness
	Perceived social influence
	Perceived ease of use
	Perceived resources
PU	Perceived ease of use
	Perceived social influence
	Perceived ease to collaborate
	Perceived psychological readiness
	Perceived resources, perceived social influence
	Perceived skill readiness
PPR	Perceived resources
	Perceived social influence
	Perceived enjoyment
PEOU	Perceived psychological readiness
	Perceived resources
	Perceived social influence
	Perceived skill readiness
	Perceived enjoyment

Table 6.2 shows the profile of the interviewees. There were four males and eight females.

Table 6.2: Participant profile

Participant type	Code	Gender	Age	Subjects
Parents	P1	Female	45	
	P2	Female	51	
	P3	Female	38	
Teachers	T1	Male	47	Mathematics and Accounting
	T2	Female	34	Physical Science and Mathematical Literacy
	T3	Female	26	Life Sciences and Natural Sciences
Learners	L1	Male	17	Mathematics, Physical Science, Life Sciences
	L2	Male	18	Mathematics, Computer Applications Technology, Life Sciences
	L3	Female	19	Mathematics, Physical Science, Life Sciences
	L4	Female	17	Mathematics, Geographic, Life Sciences
	L5	Female	20	Mathematics, Physical Science, Life Sciences
	L6	Male	19	Mathematics, Physical Science, Engineering Graphics and Design

6.2 The Factors That Affect the Rural High School STEM Learners' BI to Use M-learning

The learners' interview schedule consisted of questions that were related to every construct that was part of the learners' acceptance of mobile learning model's inner model. The rural high school STEM learners were asked to elicit details on how these factors affect their acceptance of mobile learning.

- ***Does your attitude towards the use of mobile learning affect your intention to use it?***

Rural high school learners said they want to use mobile learning for STEM learning. They gave different reasons, such as it prepares them for academic life after high school and reduces the number of books they carry to school.

One learner wrote,

"In the future it's something I will use. Especially in varsity whether you like it or not, *you will have to use it. It is better if you have used it in high school*, *so that when you get into the university you already have the skill needed."* (L4).

Rural high school STEM learners who participated in this study were doing their last year at high school. Their behavioural intention to use mobile learning was affected by their belief that mobile learning prepares them for academic life after high school. Learners understand that mobile learning is used in most universities in South Africa, therefore, using it in high school will equip them with the necessary skills needed in institutions of high learning.

Another learner wrote,

"You will not lose your notes as all of them are packed in the cell phone… so you will not carry books anymore." (L1)

What can be drawn from learners' responses is that their positive attitude towards mobile learning is caused by their belief that it will help them to prepare for university life, enable them to carry their notes everywhere and minimize the number of books they have to carry to school. The ability of mobile learning to provide learning material anywhere and prepare them for university life influences their behavioural intention to use mobile learning.

- **Does what other people around you say about mobile learning influence your decision to use mobile learning?**

Learners were asked to find out who (if anyone) they thought affects their intention to learn STEM using mobile learning. Learners stated that their teachers do not expect them to use mobile learning.

"Cell phones, *tablets*, *and laptops are not allowed at school*, *they will take them and make you pay money to get them at the end of the term."* (L2).

This shows that teachers and school policies do not encourage learners to use M-learning. Rural high school STEM learners' decision to use mobile learning is not positively affected by what their teachers say about mobile learning. By taking learners' mobile devices brought to school, teachers are sending a message that mobile learning is not useful for STEM learning.

There are some contradictions on the effect of what parents say on rural high school STEM learners' behavioural intention to use mobile learning. The minority of parents do not expect their children to use mobile learning. L1 commented that,

"If our parents see us using cell phones, *they automatically think that were busy with WhatsApp."* (L1).

This shows that some parents do not perceive that mobile devices can be used for learning. Consequently, they do not perceive mobile device usefulness for learning STEM-related subjects. Some parents do not say positive things about mobile learning and therefore, they do not encourage their children to use mobile learning. On the contrary, other parents support and encourage their children to use mobile learning as highlighted by one of the learners,

"I always lose notes and textbooks, *my mom actually bought me a tablet"* (L4).

This shows that most parents encourage and support their children to use mobile learning. Parents are supporting their children to use mobile learning by buying them the required devices. This implies that most parents say positive things about mobile learning and encourage their children to use it. For most rural high school STEM learners, what their parents say about mobile learning positively affects their behavioural intention to use mobile learning.

All learners agree that positive social influence comes from peers. Another learner stated that,

“Our friends do kind of promote because they kind of understand and most of them are using it anywhere.” (L3).

Rural high school STEM learners encourage each other to use mobile learning. It can be noted that some learners who are already informally using mobile learning to learn STEM-related subjects have realized its benefits, and hence say positive things about it. It is this encouragement that comes from their peers which positively influences their behavioural intention to use mobile learning. The conclusion that can be drawn from the learners’ responses is that the positive social influence to use M-learning is not coming from their teachers but from their peers and most of their parents.

Do the benefits of mobile learning influence your decision to use it?

Rural high school STEM learners were asked if the perceived benefits of using mobile learning influences their behavioural intention to use it. Most learners believe that the usefulness of mobile learning influences their decision to use of mobile learning. One learner wrote,

“M-learning will help us by making the learning material easily available. I will be able to get question papers, *marking guidelines*, *free textbooks and using google to get answers.”* (L5).

Another learner added that,

“*M-learning will help us to watch science experiments instead of just listening to the teachers explaining the experiment and at is better to see a real object in motion that a picture in the book*.” (L2)

There is a lack of science laboratories, learning materials and textbooks in rural high schools. Learners believe that mobile learning will help them to overcome these challenges by making learning materials easily available and enabling them to visualize science experiments. The belief that mobile learning makes learning materials easily available and enable them to visualize science experiments, positively influence their behavioural intention to use it.

Learners also believe that using mobile learning helps them to study for longer hours as indicated by another learner,

"I do not know if it's me alone sir, *but when I am using my tablet to study*, *the blue light that comes from the tablet kind of makes not sleep. With a textbook few pages*, *I sleep without even understanding how I slept."* (L3).

STEM-related subjects are generally considered to be boring and difficult. Learners believe that the use of mobile learning will help them to study and concentrate for long hours and as a result, it will improve their performance. This belief that mobile learning can improve their performance in STEM-related subjects influences their intention to use it.

Another learner wrote,

"I will be able to carry my phone to the social grant payment points and study while I am in a queue." (L6).

In rural areas, there is a high rate of learner-absenteeism on the days of social grant collection. Learners' perception that mobile learning will enable them to learn anywhere, at any time, and reduces contact time influence their intention to use mobile learning. Generally, rural high school STEM learners' behavioural intent to use M-learning is influenced by the advantages that mobile learning brings in and outside the classroom such as enabling visualization of experiments, making learning materials easily available, reducing time lost due to learner-absenteeism and learning anywhere at any time.

- ***Does the availability of resources influence your decision to use mobile learning?***

As the study was carried out in rural areas, learners were asked the question if the availability of resources affect their decision to accept mobile learning. The type of resources that learners were asked about was the availability of an internet connection, mobile data, and mobile devices.

Most learners agreed that they have access to mobile devices that can support M-learning. One of the learners wrote,

"I have a tablet that I use for M-learning." (L4).

Another learner added,

"We have one Samsung at home. It is for my aunt, but I sometimes use it when I want to go to the internet." (L3).

This shows that even though most rural high school STEM learners do no own mobile devices that can support mobile learning, they at least have access to them at home. It is this availability of devices that affect their behavioural intension to use mobile learning.

When rural high school STEM learners were asked about the effects of the availability of data on their behavioural intention to use mobile learning, the majority of learners stated that they cannot afford the mobile data needed to support M-learning.

Another learner wrote,

"I can ask for a smartphone at home, *but the problem is data. They say I need to put my own data."* (L2).

This shows that most of the learners do have the devices or access to a shared device at home, but the challenge is data.

When asked about the availability of internet connection, most learners agree that their areas are covered by at least the three main cellular network providers. However, in some isolated cases internet connection is bad as stressed by one of the learners,

"Our house is located at the foot of the hill, *as a result*, *the internet connection is a challenge. Sometimes I have to go up the hill in search of network connection."* (L1)

The learners' responses indicated that there is internet connection in rural areas.

The conclusion that can be drawn from learners' responses is that most learners have access to mobile devices that can support mobile learning and there is internet connection in rural areas. However, most learners cannot afford data. The availability of mobile devices and internet connection positively influence rural high school learners' intention to use mobile learning.

- ***Does the effort needed to learn to use mobile learning affect your decision to use it?***

Questions that were asked targeted at getting insights on how learners perceive the extent of ease or difficulty in using mobile learning, as well as investigating if learners believe that they possess the skills needed to use mobile learning. Most rural high school STEM learners agreed that they are proficient in using mobile devices, and hence they have the required skill for mobile learning.

One learner wrote,

"I learnt to use a mobile phone when I was 11 years old." (L4). This shows that rural high school learners are skilled mobile device users.

Another one added,

"Give me a mobile device, *in two minutes I would have figure out how it functions."* (L3).

This shows that rural high school learners have the skills that are needed for mobile learning. It is this perception that they will find it easy to learn how to use mobile learning for STEM learning that influences their intention to use it. However, learners welcome further training to better their skills, as another learner indicated,

"It will be nice if we are trained to use our cell phones for learning so that we can add to what we know." (L6).

Generally, rural high school STEM learners thought that M-learning will be easy to use as they already know how to operate their mobile devices.

6.3 The Factors That Influence the Teachers' Behavioural Intention to Use M-learning

After quantitative data analysis, the interview schedule was formulated, using questions that were related to hypotheses of the teachers' acceptance of mobile learning model. Since the objective of this study was to find the determinants of mobile learning, only the factors that influence teachers' acceptance of mobile learning were considered in the teachers' interview schedule. Teachers were asked to elicit details on how do these factors affected their adoption of mobile learning.

- ***Do the benefits of mobile learning influence your decision to us it?***

Teachers were asked about the advantages of using mobile learning in teaching STEM-related subjects' processes, as well as whether they believed that mobile learning would contribute to improvements in the teaching process of STEM-related subjects. Most teachers believe that mobile learning will ease the process of teaching STEM-related subjects by helping in shortening preparation time for experiments and also not to waste money on replacing finished chemicals and broken apparatus. Another teacher wrote,

"On-line experiments reduce preparation time and no need to buy chemicals and other instruments that may be broken." (T1).

One teacher wrote,

"M-learning will help a lot; just imagine you download a video on a particular experiment then you show learners then you explain. It will be better than just telling them as if you are telling them history." (T2)

Most teachers in rural areas do not do experiments with learners due to the lack of science laboratories and science equipment needed for experiments. They thought that mobile learning will assist them in demonstrating these experiments using visual experiments. Rural STEM teachers' behavioural intention to use M-learning is affected by their perception that mobile learning will enable them to use visualized experiments. Visualized experiments aid teachers in explaining science concepts and decrease lesson preparation time. Visualized experiments can be paused and repeated several times to enhance understanding.

Teachers also agree that mobile learning will help them to supply learning materials to learners easily. T2 wrote,

"Printing copies at my school is a problem, *the school does not have money*, *so M-learning would help us a lot… just imagine sent a document with 1000 pages worth of questions to learners."*

This shows that rural high schools lack textbooks, learning materials, and stationery. Thus, the ability of mobile learning to make learning materials available to learning influences rural high school STEM learners' behavioural intention to use it.

Moreover, rural high school STEM educators generally felt that the use of mobile learning was popular with learners and T2 wrote that,

"It aids learners in memorizing the content." (T2).

The teacher added,

*"There is no doubt that its introducing M-learning will improve learners' performance and it adds some excitement and thrill into the science classroom." (*T2)

Teachers' comments show that they perceive that the use of mobile learning will improve their learners' performance. They believe that since STEM-related subjects are considered boring and introducing mobile learning will bring excitement and change the negative attitudes of learners towards STEM-related subjects. Teachers also believe that mobile learning will help learners to memorize content and in turn improve their performance. The belief by rural high school STEM teachers that mobile learning improves learners' performance influences their behavioural intention to use M-learning.

- ***Does the effort needed to learn to use mobile learning affect your decision to use it?***

Questions about perceived ease of use were aimed at determining how educators perceive the degree of ease or difficulty in using mobile learning and also to find how the degree of ease of difficulty influences their behavioural intention to use mobile learning. All the educators showed that they needed to be trained to be able to use mobile learning for teacher STEM-related subjects. One teacher stated that they do not possess the skills needed for mobile learning. T2 wrote,

"As for me typing is a problem, *I am very slow as a result the use of M-learning will increase the preparation time."* (T2).

One commented,

"We really need training not what the Department usually does." (T3).

Another one added,

"You are right this thing of one day workshop is not going to work." (T2)

Teachers' comments show that most of them are not proficient mobile devices users, however, they possess minimum skills that enable them to operate the devices. The teachers also stressed the need for thorough training before the implementation of mobile learning. This shows that rural high school STEM teachers' behavioural in00tention to use M-learning is influenced by the minimum skills they possess and the opportunity for further training.

- ***Does the availability of resources influence your decision to use mobile learning?***

Due to the setting of the study, teachers were asked about the extent to which resources in rural high school affect the successful implementation of mobile learning. Educators were therefore asked about the availability of resources in their schools that can support M-learning.

The teachers' responses revealed that rural high schools are not equipped with the equipment that can support mobile learning. One of the teachers wrote,

"There is nothing, nothing, the school does not even have a science laboratory." (T3).

This shows that some schools in rural areas do not have equipment that can support mobile learning. This was supported by other teachers who stated that some teachers end up bringing their devices to school.

Another teacher wrote,

"At my school, *we rely on another teacher's laptop to type question papers and to show learners videos*, *but it's not easy due to large numbers in classrooms." (T1).*

This shows that most rural high schools do not have the equipment that can support mobile learning. However, some teachers possess devices that can support mobile learning. It is this availability of personal devices that impact the behavioural intention to use mobile learning for rural high school STEM teachers.

In some schools, mobile devices are there but they are not made available to teachers. T2 stated that some equipment was donated by Vodacom (cellular network provider) but it is locked up inside the principal's office.

"There is a Wi-Fi router and 20 tablets that were supplied by Vodacom, *but there are locked inside the saferoom."* (T2).

This shows that in some rural schools, mobile devices are available, but they are not utilized. It is this availability of mobile devices that influence teachers' behavioural intention to use mobile learning. However, it should be noted that the equipment available is not enough for the successful implementation of mobile learning.

- ***Does your attitude towards the use of mobile learning affect your intention to use it?***

Teachers were asked questions to determine their attitude towards mobile learning. Teachers indicated that they have a positive feeling about mobile learning. The reasons they gave ranged from their belief that mobile learning will improve the learners' performance to minimizing time lost due to learner absenteeism and teachers attending workshops. Another teacher commented,

"With high failure rate in Mathematics and Science in this area, *I think its high time M-learning is introduced because it is going to improve the pass rate for these problematic subjects*" (T1).

This shows that rural high school STEM teachers' perception that M-learning can improve learners' performance influence their behavioural intention to use M-learning.

Teachers also believe that the use of M-learning will minimize time loss. Another one commented that,

"M-learning will help to reduce time lost, *due to these social grants collection days. You just cover a lot of content a day before and sent it to them as homework."* (T2).

Another teacher added,

"… *or a day before moderation or any other content workshop you can do the same*." (T1).

Rural high school STEM teachers agree that M-learning reduces time lost due to teacher absenteeism and learner's absenteeism, and, as a result, they have a positive attitude towards M-learning. It is this positive attitude towards mobile learning that influences their behavioural intention to use M-learning.

6.4 The Factors That Influence the Rural High School STEM Learners' Parents' Behavioural intention to Use mobile learning

The results of the quantitative data analysis informed the questions to be added to the interview schedule. The questions were formulated only from the constructs that have a direct or indirect effect on behavioural intention to use mobile learning. Parents of rural high school STEM learners were asked questions on the factors that cause them to allow their children to accept mobile learning.

- ***Does your attitude towards the use of mobile learning affect your intention to allow your child to use it?***

Parents of rural high school STEM learners were asked to determine their perceptions towards mobile learning. Generally, parents show mixed feelings towards mobile learning. Most parents were positive about mobile learning, but a minority of parents had negative attitudes.

Of those who were positive, their reasons ranged from their belief that mobile learning will improve their children's performance in STEM-related subjects to providing learning materials.

Another parent wrote,

"I am looking forward for my child to pass, *the use of technology will make him pass."* (P2).

One parent wrote,

"My child is sharing textbook with other child, *and they stay very far away from each other making doing homework difficult."* (P3).

This shows that parents of rural high STEM believe that mobile learning will make learning materials available and this will improve the performance of their children. Parents of rural high school STEM learners' behavioural intention to allow their children to use mobile learning is influenced by their belief that it will improve their children's performance in STEM-related subjects.

However, some parents expressed a negative attitude towards mobile learning. The negative comments showed that some parents do not fully understand how mobile learning functions. Another parent wrote,

“Teachers will not be coming to school they will just send studying material to learners and this will affect their performance.” (P1)

This shows that some parents of rural high school STEM learners are not acquainted with mobile learning, and, as a result, they have a negative attitude towards it.

It was not very clear about the attitudes of parents towards mobile learning. However, all parents agreed that mobile learning will improve their children’s performance in STEM-related subjects. This belief was strong enough even for parents who were not positive towards the idea of accepting mobile learning. This showed that the parents’ attitudes towards mobile learning were mainly influenced by their belief that it can improve their children’s performance in STEM-related subjects, and this belief influences their behavioural intention to use mobile learning.

- **Is your decision to use mobile learning influenced by people around you*?***

The parents of rural high school STEM learners were questioned to find out who (if anyone) they think might influence their decision to allow their children to use mobile learning. They were also asked about the attitude of other parents towards mobile learning. The parents said their decision to allow their children to use mobile learning was influenced by their children and other family members. One of the parents wrote,

“My child showed me how they can use M-learning to watch other teachers teach the same thing that their teacher was teaching them in class.” (P1).

The parent further added,

“My child and her friends always help each other with mathematics problems by taking photos and sending them through WhatsApp.” (P1).

This shows that parents of rural high school STEM learners are not resistant to what their children tell them about mobile learning. It is the good things they hear about mobile learning from their children that influence their behavioural intention to allow their children to use it.

Another parent added that other family members who live in town influence them to allow their children to use mobile learning. The parent commented,

"When they come for weekends or if you visit them, their children will be using cell phones for everything, from learning to playing games. When you ask their parents why, they always say that is how they are learning these days." (P3).

Parents of rural high school STEM learners are influenced to allow their children to use mobile learning by other family members. This shows that rural high school STEM learners' parents positively influence each other to allow their children to use mobile learning.

When parents were asked if teachers will influence them to allow their children to use mobile learning, they stressed that teachers do not even support the use of mobile learning. Parents also revealed that the school's rule does not allow their children to have a cell phone at school. Another parent wrote,

"Teachers do not expect us to allow our children to learn using their phone. If a child carries a phone to school and they found out, they take it and call us to come with R150 to pay so that we can get the phone back." (P1).

The parent added,

"They say phone disturbs them in class and learners will waste time on social media." (P1).

This means that parents of rural high school STEM learners are not influenced by teachers of their children to allow their children to use mobile learning.

The responses of parents of rural high school STEM learners revealed that they are not resistant to what they hear about mobile learning. The positive influence for parents to allow their children to use mobile learning come from their children and other family members. The positive influence from children and other family members influence parents' behavioural intention to allow their children to use M-learning.

- ***Does the availability of resources influence you to allow your child to use mobile learning?***

Perceived resources affected almost all other constructs of the original Technology Acceptance Model when quantitative data analysis was carried out, and thus it was imperative to ask parents questions whether the availability or unavailability of resources influence their behavioural intention to allow their children to use mobile learning.

When parents were asked about the availability of resources parents unanimously agreed that they do not have all the resources needed for mobile learning. They also agreed that perceived resources affect their behavioural intention to allow their children to use mobile learning.

Another parent wrote,

"Most of us we live on social grants, *as a result even if we want them to use M-learning we cannot provide them with phones and data."* (P1).

Another parent added,

"Providing our children with cell phones is a challenge. My child is using his sister's old phone that she gave it to me." (P2).

This shows that some parents cannot afford to buy their children mobile devices and data. However, in most cases, rural high school STEM learners have access to mobile devices that can support mobile learning at home. The availability of mobile devices at home positively influence parents' behavioural intention to allow their children to use mobile learning.

When parents were asked about the availability of mobile data, most of them agreed that they have challenges with mobile data. Another parent wrote,

"My challenge is buying data. Data is very expensive, and it is quickly used up because of poor connection where they try to see the same thing for several times." (P3).

This shows that there is bad internet connection in rural areas. The parents' responses also show they have challenges with data. What can be learnt from parents' response is that most of their children have access to mobile devices and an internet connection, but the only challenge is buying data. It is this availability of mobile devices and internet connection that influences their behavioural intention to use M-learning.

- ***Does the effort needed to learn to use mobile learning influence your decision to allow your child to use mobile learning?***

Questions about perceived ease pf use were aimed at determining how parents of rural high school STEM learners think about how easy or difficult will it be for their children to learn to use M-learning. Generally, parents feel that it is going to be easy for their children to use M-learning as they (children) are proficient mobile devices users.

Another parent wrote,

"I think it is going to be easy for my children to use M-learning. They know how to use cell phones better than what I do." (P3).

This shows that parents believe that it is going to be easy for children to use mobile learning as they are good at using mobile devices.

However, parents are worried about the time that their children need to put in learning how to use mobile learning. One of the parents commended that,

"My child is now in grade 12, *all I want is for him to pass. So, if M-learning is difficult to learn it will take up his time."* (P1).

This shows that parents consider the effort needed to learn to use mobile learning when accepting it to be used by their children. The parents' behavioural intention to allow their children to use mobile learning is influenced by their belief that their children will find it easy to use mobile learning.

- **Do the benefits of mobile learning influence you to allow you child to use it?**

Parents of rural high school STEM learners were asked about the advantages of using mobile learning as well as whether they believed that it would improve their children's performance in STEM-related subjects. Parents showed that they are not clear about the benefits that M-learning bring into the classroom, but they believe that mobile learning will improve their children's performance in STEM-related subjects.

One parent wrote,

"*I am not sure about the benefits*, *but all I know is my child will be able to get some question papers."* (P3).

Another one wrote,

"Learners will be typing their notes, *not writing them."* (P1).

One parent wrote,

"All I see my child doing is to send and receive some questions from his friends. I also see him reading on the phone." (P2)

The parents' responses show that parents are not clear about the benefits of mobile learning.

When asked about whether they think mobile learning will improve their children's performance in STEM-related subjects, parents unanimously agree. One parent wrote,

"It will definitely improve our children's performance." (P3).

This shows that parents have very little knowledge about the usefulness of M-learning but hold a belief that it will improve the performance of their children. It is this belief that mobile learning will improve their children's performance in STEM-related subjects that influence their behavioural intention to allow their children to use it.

6.5 Combining Qualitative and Quantitative Data

The study followed an explanatory sequential mixed-methods approach to find facts that rural high school STEM learners, their teachers, and parents consider important when accepting mobile learning for STEM learning. An explanatory sequential mixed-method approach involves a two-phase project in which the quantitative data are collected in the first phase, analysed to get the results, and then the results are used to inform (or build on to) the second, qualitative phase (Creswell, 2013).

In the current study, a questionnaire was used to collect quantitative data. The data were then analysed using PLS-SEM. SmartPLS 3 software was used to analyse data and the results were presented in Chapter 5. As the main aim of the study was to find the determinants of acceptance of mobile learning in rural areas, all significant hypotheses informed the questions to be included in the interview schedule. The researcher then conducted the interviews (Phase Two) and the results were presented in this chapter.

The researcher followed the suggestion by Creswell (2013), that the overall intention of the explanatory sequential mixed-methods approach is to have the results of quantitative data explained in more detail by the qualitative data. With this intent, the questions asked in the interviews sought some explanation as to why the factors identified in the quantitative data influence rural high school STEM learners, their teachers, and parents to accept mobile learning. According to Creswell (2013), the sequential approach allows the researcher to join the two databases (qualitative and quantitative), by building the one database on the other. Following this suggestion, the quantitative and qualitative results were combined and used to answer the same research questions. The quantitative and qualitative data were simultaneously interpreted, one building on the other. For instance, the results of hypotheses testing were interpreted, and qualitative data were used to support the findings by providing a detailed picture of the mobile learning experiences of the participants. The next chapter presents the interpretation of the results.

6.6 Summary

The qualitative data collected largely reinforced the findings of quantitative data analysis. The qualitative data analysis also revealed that there were fundamental issues specific to the acceptance of mobile learning in South African rural areas. The results showed that all the groups' (teachers, learners, and parents) behavioural intention to use mobile learning was influenced by almost the same factors (PU, PEOU, PR, ATT, and PSI). The study also revealed that all the groups (teachers, learners, and parents) had a positive attitude towards mobile learning, but learners were more positive than their teachers and parents. The results also showed that parents were not clear about the benefits of M-learning in the classroom. Both learners and teachers welcome further training on how to effectively use mobile learning for teaching and learning STEM-related subjects. The study also revealed that there are not enough resources that can support mobile learning in rural high schools and at learners' homes. The following chapter will explore the fundamental issues about mobile learning acceptance in South Africa and combine the results of qualitative and quantitative studies and evaluate what these results mean in terms of answering the research questions.

CHAPTER 7 DISCUSSION OF RESULTS

7.1 Introduction

The previous chapter presented an analysis on the findings of this study. The aim of Chapter 5 and Chapter 6 was to empirically examine the SASTAM and potential predictors of rural high school STEM learners', their parents', and teachers' behavioural intention to accept mobile learning for STEM teaching and learning. In doing so, the structural models were evaluated. In alignment with the findings of Chapter 5 and Chapter 6, this chapter aims to discuss the possible justifications for the significance of the relationships proposed in the conceptual model (see Figure 3.5).

Additionally, this chapter analyses the results of the current research in the light of existing literature and reports the consistency or inconsistency of the research findings with prior studies. Specifically, followed by the introduction, section 7.2 to section 7.5, which presents a discussion of the findings of SASTAM, which aims to answers the research questions. The questions aimed at how do predictors such as perceived enjoyment, perceived psychological readiness, perceived skills readiness, perceived social influence, perceived resources, perceived ease of use, perceived usefulness, perceived attitude towards , and perceived ease to collaborate influenced rural high school STEM learners', their parents' and teachers' behavioural intention to use mobile learning for STEM teaching and learning.

The results of research question 1 are discussed in Section 7.2. Section 7.3 presents the findings of research question 2, which aimed at finding factors that rural high school STEM teachers consider important when accepting mobile learning. The aim of research question 3 was to find out the effects of predictors on the behavioural intention of parents of rural high school STEM learners to accept mobile learning; the results are discussed in section 7.4. The results of research question 4 are discussed in Section 7.5. Finally, the summary of this chapter is presented in section 7.6.

7.2 The Effect of Predictors on Rural High School STEM Learners’ Behavioural Intention to Use M-learning

The purpose of objective 1 was to investigate the factors that affect rural high school STEM learners’ BI to use M-learning for STEM learning. Based on the SASTAM model proposed in Chapter 3, PLS-SEM was used to assess the hypotheses. The learners’ acceptance of mobile learning model’s structural model, given in Figure 5.3, was analysed by assessing the R-squared value (variance explained); structural paths (path coefficient); the effect size (f-squared) and predictive relevance (Q-squared). However, as the aim of these question was to find the predictors of rural high school STEM learners’ behavioural intention to use mobile learning, only significant paths (predictors) were discussed in this section.

The results indicated that the proposed model adequately explained the variance in behavioural intention and has the ability to predict rural high school STEM learner’s Behavioural intention to accept mobile learning. The model explains 44.3% of the variance in behavioural intention to use M-learning. The R-squared (shared variance explained by exogenous constructs) is moderate, according to Chin (1998). This implies that the combined effect of the factors, perceived ease of use, perceived usefulness, perceived resources, perceived attitude towards, and perceived social influence, in explaining rural high school STEM learners’ behavioural intention to use mobile learning was 44.3%.

The results of the learners’ mobile learning acceptance model are in line with the results of four studies carried out by Venkatesh and Davis (2000), who stated that the R-squared of the extended TAM ranges from 37% to 52%. Perceived resources explained 3.2% of the variance in perceived ease of use. Perceive ease of use explained 12.7% of the variance in perceived usefulness, while perceived resources and perceived usefulness explained 24.3% of the variance in perceived attitude towards. The variance explained in perceived ease of use, perceived usefulness and perceived attitude towards the use was considered small (Chin,1998).

The Q-squared values were all above zero, indicating that the model had predictive relevance (Garson, 2016; Hair et al., 2017). This implies that the learners’ acceptance of mobile learning model can predict rural high school STEM learners' behavioural intention to use mobile learning. In other words, the factors perceived ease of use, perceived usefulness, perceived resources, perceived attitude towards, and perceived social influence positively affect rural high learners' behavioural intention to use mobile learning. In supporting these finding, the results of the indirect hypotheses test showed that all predictors on the model had a significant effect on behavioural intention to use mobile learning.

Perceived attitude towards the use had the highest f-squared value of 0,47, followed by perceived usefulness (0.34), perceived ease of use (0,32), and then perceived social influence, with the f-squared value of 0,31. The f-squared of perceived attitude was considered high (Hair et al., 2017). This implies that the contribution of perceived attitude towards the use on the explained variance in behavioural intention is high. This means rural high school learners' perceived attitude towards the use contributes more to their intention to use mobile learning than perceived usefulness, perceived social influence and perceived ease of use. Perceived usefulness', perceived social influence's and perceived ease of use's contribution on the variance in BI were considered to medium (Hair et al., 2017). This means that rural high school STEM learners' perceived usefulness, perceived social influence and perceived ease of use all play an important role in their acceptance of M-learning.

The summary of all the paths is presented in chapter 5, Table 5.9. Table 5.11 also shows the results of significant indirect paths. Seven out of nineteen relationships were not significant. The relationships which were not significant were H4a, H3b, H2e, H1d, H3d, H3e, and H4c. This implies that rural high school STEM learners' perceived resources do not influence their belief that mobile learning can improve their performance in STEM-related subjects and their behavioural intention to use mobile learning. For rural high school STEM learners, the usefulness and ease of use of mobile learning were not determined by how easy it is to collaborate. It is interesting to note that rural high school learners were not influenced by what other people say to them about mobile learning. This is because rural high school learners know the usefulness of mobile learning more than the people who important to them (teachers and parents). Furthermore, this also means that people around learners are not saying positive things about mobile learning.

This was highlighted in the interview by P1 who stated,

"*My child showed me how they can use M-learning to watch other teachers teach the same thing that their teacher was teaching them in class*."

This shows that rural high school STEM learners understand the utility of M-learning more than the people who are important around them. Consequently, what people say to them does not affect their belief that mobile learning will improve their performance in STEM-related subjects. Additionally, this also means that people around and important to learners might be saying negative things about mobile learning, but they (learners) know the benefits of mobile learning.

Hypothesis H1a: ATT has a significant effect on BI to use

The results of the current study confirmed the results of Al-Emran et al. (2019) and Saroia and Gao (2018), who collectively found that learners' perceived attitudes positively influence their behavioural intention to use M-learning. This path between perceived attitude towards the use was also validated in many Technology Acceptance Models studies (Davis, 1989; Mathieson et al., 2001). Furthermore, the theory of reasoned action (TRA) by Fishbein and Ajzen (1975) also confirms the casual relationship between perceived attitude towards and behavioural intention. Therefore, along with those prior studies, the results of this study further confirmed that users' behavioural intention to use any information system is influenced by their perceived attitude towards the use.

In the current research, the path coefficient between perceived attitude towards the use and behavioural intention showed ($\beta = 0.441$, $p < .05$). This means that an increase of one unit in perceived attitude towards, will significantly increase behavioural intention with about 0.441 unit. The results suggest that rural high school STEM learners' behavioural intention to use mobile learning is reinforced by their positive feelings towards mobile learning.

These findings were reflected in the interviews, when rural high school learners stated that their positive attitude towards mobile learning was caused by their belief that it prepares them for academic life after high school. P4 wrote, "*In the future it's something I will use. Especially in varsity whether you like it or not*, *you will have to use it. It is better if you have used it in high school so that when you get into the university you already have the skill needed*."

This is so specifically because the participants are doing their final year in high school and are anticipating to go to university thereafter. Therefore, their behavioural intention to use mobile learning was influenced by their belief that it prepares them for university life.

Hypotheses H1c: PU has a positive influence on BI

High school STEM learner's perceived usefulness was found to positively affect their behavioural intention to use mobile learning. This finding supported hypothesis H1c ($\beta = 0.241$, $p < .05$). This result means that if rural high school STEM learners' perceived usefulness increases by one unit, their behavioural intention will also increase by 0.241. This is inconsistent with Mathieson et al. (2001), who reported an insignificant value ($\beta = 0.003$, $p > .05$) on the same path. Unlike those learners in Mathieson et al.'s (2001) study, rural high school STEM learners believe that mobile learning will enable them to have access to learning materials and to visualise science experiments, which will, in turn, improve their performance in STEM-related subjects (Bransford et al., 1999; Criollo-C et al., 2018).

It is this belief that M-learning can improve their performance that influences their acceptance of mobile learning. This is explained by the fact that the participants of the current study were in an examination class where they were under pressure to have good results in STEM-related subjects. It can be inferred that rural high school STEM learners' belief that using mobile learning could improve their performance in STEM-related subjects positively influences their behavioural intention to use mobile learning.

These findings were also stressed during the interview. Rural high school learners highlighted ways in which they felt that mobile learning will be useful to them, such as virtual laboratories being safer, and the experiment may be repeated several times without wasting chemicals. Learners also stressed the availability of additional learning materials and watching you-tube videos on the section they did not understand in class. All these benefits of M-learning are stated by Bransford et al. (1999) and Criollo-

C et al. (2018). However, rural high school learners also revealed something new that mobile devices help them to concentrate for long hours than a textbook.

L3 stated,

"*I do not know if it's me alone sir*, *but when I am using my tablet to study*, *the blue light that comes from the tablet kind of makes not sleep. With a textbook few pages*, *I sleep without even understanding how I slept*."

This shows that rural high school STEM learners perceive that using mobile devices to learn STEM-related subjects increases their studying time, which in turn improves their performance. It is the belief that using mobile learning will increase their studying time and performance in STEM-related subjects that influences their behavioural intention to use mobile learning.

Hypotheses H1e: PEOU significantly affect BI

The interviews revealed that learners were proficient users of mobile devices, thus using the same devices for learning is going not a challenge. Most learners agreed that most mobile learning platforms were clear and easy to use for learning STEM-related subjects. However, there was a minority who did not agree, who felt like they did not possess the skills needed and as a result they perceived it difficult to use mobile learning. Rural high school STEM learners agreed on the need for training on how to successfully use mobile learning for STEM learning.

The results of the current study contradict the results of the study by (Liu et al., 2010), who found that learners' behavioural intention to use mobile learning was not influenced by how easy the mobile learning platform is. The results of this study supported hypothesis H1e ($\beta = .152$, $p < .05$). The results of this study imply that rural high school STEM learners' decision to use mobile learning is affected by the effort needed to learn how to use the mobile learning platform. The reason for these findings is that the learners in the study were in an examination class, doing STEM subjects that are considered to be difficult (DoE, 2015). Any complicated mobile learning platform will add undue pressure on them, and as a result, they will not be keen to use it. It may be suggested that mobile learning platforms should be as user-friendly as possible to encourage rural high school learners to use them.

Hypothesis H1d: BI to use M-learning is influenced by PSI

Behavioural intention to use M-learning was affected by rural high school STEM learner's perceived social influence. These results supported the hypothesis H1b (β = .145, p <.05), implying that for every one-unit increase in rural high school STEM learners' perceived social influence, their behavioural intention to use mobile learning will increase by 0.145. The influence of peers and parents had a positive impact on high school STEM learners' acceptance of mobile learning. This finding is in line with the findings of (Pramana, 2018), who found out that university students in Indonesia are influenced to use M-learning by people who are important to them. The social influence in the study by Pramana (2018) came from lecturers and peers.

The interviews revealed a different picture when it came to the relationship between perceived social influence and behavioural intention. Most rural high school STEM learners agree that, unlike in the study by Pramana (2018), teachers do not encourage them to use mobile learning for learning STEM-related subjects. They indicated that teachers confiscated mobile devices that they brought to school.

L2 stated,

"*Cell phones*, *tablets*, *and laptops are not allowed at school*, *they will take them and make you pay money to get them at the end of the term*."

This shows that teachers do not support the use of mobile learning for STEM learning. Consequently, what teachers say about mobile learning does not influence rural high school STEM learners' BI to use mobile learning.

On the contrary, their parents, friends, and classmates encouraged them to use M-learning. (L4) commented,

"*I always lose notes and textbooks*, *my mom actually bought me a tablet*."

This shows that most parents encourage their children to use mobile learning by providing the mobile devices. Thus, what parents say about mobile learning influences their children's behavioural intention to use it.

The results of the current study revealed that rural high school STEM learners are not immune to what their parents and peers say about learning STEM using M-learning. This implies that when rural high school STEM learners know that their parents and peers approve of and perceive the benefits of mobile learning, they are most likely to accept it in the classroom. It may be suggested that for mobile learning to be successfully implemented in rural high schools, school policies need to be changed and teachers' attitudes towards mobile learning need to be managed.

Hypothesis H2a: PU significantly affect ATT the use

Rural high school STEM learners' perceived usefulness positively affects their perceived attitude towards the use of mobile learning. The results are congruent to (Li, Meng, Tian, Zhang, Ni, & Xiao, 2019; Yeap et al., 2016), who collectively found that learners' perceptions of the benefits that mobile learning brings in the classroom affect their attitude towards the use of mobile learning. The path coefficient of this linkage was ($\beta = 0.459$, $p < 0.05$). The path coefficient implies that rural high school STEM learners' perceived attitude towards will increase by 0.459 units for each one-unit increase in their perceived usefulness. This finding implies that rural high school STEM learners' feelings towards mobile learning were affected by their belief that using mobile learning will increase their performance in STEM-related subjects.

Interestingly, during the interviews, the rural high school STEM learners were strongest in their agreement that mobile learning helps in learning STEM-related subjects. Learners highlighted that the light of mobile devices helps them to study for long hours without falling asleep and that improves their performance. (L3) stated,

"I do not know if it's me alone sir, *but when I am using my tablet to study*, *the blue light that comes from the tablet kind of makes not sleep. With a textbook few pages*, *I sleep without even understanding how I slept*".

This shows that mobile devices will help learners to study better than textbooks. They also stated that it is interesting to use mobile learning as it shows real objects in motion than pictures in the book.

Another learner wrote,

"*M-learning will help us to watch science experiments instead of just lessoning to the teachers explaining the experiment and it is better to see a real object in motion that a picture in the book*." (L2)

This shows that rural high school learners believe that M-learning will help them to visualise experiments and watch real objects instead of pictures in the books. The interview showed that rural high school STEM learners' positive feelings towards the use of mobile learning was influenced by their belief that using mobile learning will improve their performance in STEM-related subjects.

Hypothesis H4e: PR positively affect PEOU

Concerning the relationship between PR and PEOU, the results show that rural high school STEM learners' perceived resources positively affects their perceived ease of use ($\beta = .175$, $p < .05$), and thus supporting hypothesis H4e. The results imply that for every one-unit increase in high school STEM learners' perceived resources, their perceived ease of use will increase by 0.175. These results are congruent to the findings of (Ku, 2009; Mathieson et al., 2001; Sivo et al., 2018), who collectively found that university learners' perceived resources influence their perceived ease of use. Even though the results are congruent, the resources referred to in these studies are different. In the studies by Ku (2009), Mathieson et al. (2001) and Sivo et al. (2018), the resources they were referring to were the availability of technical support of online learning in a university context where the resources are provided for. In the current study, the resources that were referred to are the availability of mobile devices, internet connection, and data with which rural high school STEM learners need to provide themselves.

Contrary to the results of the study by Pimmera, Brysiewicz, Linxen, Walters, Chipps, and UrsGröhbiel (2014), the learners revealed that they had access to an internet connection and the mobile devices that are needed for M-learning. Learners revealed that some of them own the devices while some have access to shared devices at home.

This was written by (L4),

"*I have a tablet that I use for M-learning*."

And (L3),

"*We have one Samsung at home. It is for my aunt, but I sometimes use it when I want to go to the internet*."

This shows that rural high school STEM learners have devices that can support mobile learning. It is the availability of mobile devices at home and an internet connection that influenced their behavioural intention to use M-learning.

Hypothesis H3a: PEOU influences PU

The results of the path between PEOU and PU was not consistent with the findings from the study conducted by Sánchez-Prietoa et al. (2019) and Saroia and Gao (2018), which demonstrated an insignificant relationship between PEOU and PU. The results of the current study support H3a (β = .355, p <. 05). The results mean that high school STEM learners' perceived usefulness will increase by 0.355 for every one-unit increase in perceived ease of use. This path coefficient is considered moderate (Pallani, 2010). The results suggest that for rural high school STEM learners, the belief that M-learning will improve their performance in STEM-related subjects depends on the effort required to learn to use the mobile learning platform.

The rural STEM learners who participated in this study were under pressure to pass their matriculation, and as a result, mobile learning platforms which are difficult and confusing will increase pressure on them unnecessarily and might not be utilised. This also came out in the interview; the learners stated that platforms that are difficult to learn will take time that should be used to learn subject content.
(L6) wrote,

"*I can't have challenges with both content and learning to use M-learning, if it's difficult to use, I will not use*."

This shows that learners will resist using mobile learning platforms which are difficult to learn. Thus, rural high school STEM learners' behavioural intention to use M-learning is influenced by the effort needed to learn to use the platform.

However, other learners were very positive; they said they liked it because answers were just a click away. This showed that for rural high school learners, the belief that the use of M-learning improves performance in STEM-related subjects depends on the perceived effort required for learning to use M-learning. Thus, M-learning must be as user-friendly as possible for rural high school STEM learners to utilise it for STEM learning.

Hypothesis H2c: Perceived resources have a positive effect on ATT use

The results show that perceived resources directly affect perceived attitude towards the use. The results are inconsistent with the findings of the study that were carried out by Ku (2009) and Mathieson et al. (2001), who reported an insignificant relationship between PR and PEOU. The results contradict Mathieson et al.'s (2001) suggestion that one can have a positive attitude towards the use of an information system, even though there are no resources.

The results of the path coefficient show a significant coefficient beta ($\beta = .150$, $p<.05$), thus supporting hypothesis H2c. The availability of resources affects rural high school STEM learners' feelings towards mobile learning, which in turn affects their acceptance. These findings were not surprising due to the rural environment in which the study was conducted. In these rural areas, most families live in poverty and rely on social grants (Mboweni, 2014). In these conditions, learners' attitudes towards the use of mobile learning are influenced by the availability of resources.

In the interviews, learners stated that most of them have access to a home smartphone, but which they may need to share with others, and this, in turn, demotivates them. However, other learners have their own devices, but they do not have data. This shortage of data demotivates them. Only a minority agreed that they have both data and devices needed, and as a result they are already using mobile learning. The conclusion that may be drawn from these results is that, for the successful implementation of mobile learning for STEM learning in rural areas, resources need to be provided. Table 7.1 presents a summary of the findings that were presented in this chapter.

The Effect of Predictors on Rural High School Stem Learners' Behavioural Intention to Use M-learning

7.3 The Effects of Predictors on Rural High School STEM Teachers' BI to Use M-learning

Objective 2 aimed to gain an understanding of the factors that rural high school STEM teachers consider important when accepting mobile learning. Based on the SASTAM model proposed in Chapter 3, the hypotheses were then tested in Chapter 5 section 5.5.2.2. Contrary to the results of the original Technology Acceptance Model Davis

(1989), extended Technology Acceptance Model Mathieson et al. (2001), Venkatesh (2000) and Ku (2009), who collectively found that perceived usefulness predicts behavioural intention, the results of this study showed that only perceived attitude towards the use directly influences rural high school STEM teachers' BI to use M-learning. This indicated that for rural high school STEM teachers, the usefulness of mobile learning does not directly affect their intention to use mobile learning, only their attitude does.

Another surprising result was the relationship between perceived ease of use and perceived usefulness. The result showed that perceived ease of use does not influence perceived usefulness ($\beta = .165$, $p > .05$). These results were contrary to the findings of the original Technology Acceptance Model by Davis (1989), and Nikou and Economides (2018), Ku (2009) in the mobile learning context. The results also showed that perceived resources was the only construct that was added to the Technology Acceptance Model, which affected rural high school STEM teachers' behavioural intention to accept M-learning. This emphasises the importance of providing resources for the successful implementation of mobile learning.

The results showed that the proposed model adequately explained and predicted behavioural intention of rural high school STEM teachers to use mobile learning. The results show that the R-squared values of perceived attitude towards and behavioural intention were 0.437 and 0.438 respectively; these R-squared values were considered to be of moderate strength (Chin, 1998). The model explained 43.8% of the variance in behavioural intention to use mobile learning. This implies that the combined effect of the factors; PEOU, PU, PR, and ATT, in explaining rural high school STEM teachers' behavioural intention to use mobile learning was 43.8%.

The R-squared value of the current study was consistent with Venkatesh and Davis' (2000) suggestion that the R-squared of the extended TAM ranges from 37% to 52%. The model also explained 43.7% of the variance in perceived attitude towards the use. This means that the total contribution of the factors PEOU, PU and PR in explaining rural high school STEM teachers' attitudes toward M-learning was 43.7%.

These results also show that all the Q-squared values were greater than zero, supporting the predictive relevance of the model (Hair et al., 2014). This indicated that the teachers' acceptance mobile learning model can predict rural school high school STEM teachers' behavioural intention to use mobile learning. The Q-squared value of behavioural intention was greater than zero, which indicated that perceive resources, perceived ease of use, perceived attitude towards the use and perceived usefulness positively predict the behavioural intention of rural high STEM learners to use mobile learning.

The f-squared values range from 0.07 to 0.44, meaning that the effect size of exogenous on the endogenous variable ranged from small to large. The f-squared value of perceived attitude (0.44) on rural high school STEM teachers' behavioural intention to use M-learning is considered high (Hair et al., 2017). This implies that the contribution of ATT to the explained variance in behavioural intention was high. The following section discusses all the significant hypotheses for this objective.

- ***Hypothesis H4e: PR has a significant effect on PEOU***

The results showed that perceived ease of use was significantly influenced by perceived resources. These results are similar to the findings of (Nikou and Economides (2018); Nikou and Economides (2019)), who reported that teachers' facilitating condition (perceived resources) was the best predictor of their perceived ease of use. Even though the results of this study were similar to the results of Nikou and Economides (2019), the type of resources referred to are different. In the study by Nikou and Economides (2019) perceived resources referred to the availability of appropriate technical and administrative infrastructure that can support mobile learning. The resources such as devices and data were supplied.

In the current study, perceived resources refer to the availability of mobile devices, internet connection, and data. Teachers need to provide themselves with data and mobile devices. These findings imply that the availability of mobile devices, network connectivity and mobile data enhances teachers' perceptions of the effort needed for learning to use mobile learning platforms for STEM teaching. The path coefficient of

($\beta = .381$, $p < .05$), thus supported hypothesis H4e. These results mean that rural high school teachers' perceived ease of use increases by 0.381 when their perceived resources are increased by one-unit. It is reasonable to infer that rural high school STEM teachers believe that if resources are made available, they will find it easy to learn and to be skilful in teaching STEM-related subjects using M-learning.

Table 5.32 also indicates that perceived resources has an indirect effect on BI through ATT and PEOU. The results of the current study confirmed the results of several previous studies that conclude that facilitating conditions (perceived resources) influence the adoption of new technologies (Panda & Mishra, 2007; Teo, 2010, 2011; Yeop, Yaakob, Wong, Don, & Zain, 2019). This finding implies that teachers' decision to use M-learning for STEM teaching is partially affected by the availability of resources.

Rural high school STEM teachers unanimously agreed that perceived resources affect their beliefs on how easy it is to use M-learning. The interviews revealed that in high schools there were no basic resources, such as enough furniture and books, let alone equipment, that can support mobile learning. One of the teachers stated that there was only one laptop for the school and that laptop belonged to the school principal alone. Teachers alluded to the fact that even when it comes to the typing of question papers, they rely on other teachers' laptops.

(T1) stated,

"A*t my school*, *we rely on the other teacher's laptop to type question papers and to show learners some videos*, *but it's not easy due to large numbers in class*."

This shows that rural high schools do not have some of the resources needed to support M-learning. These results also indicated that in rural high schools, the infrastructure is not there or not yet satisfactorily developed to properly support mobile learning and there was very poor internet connection. Teachers also stressed that because of the unavailability of resources, they do not have the skills to use mobile learning. However, they all welcome the opportunity to be trained.

- ***Hypothesis H2b: PEOU has a significant effect on ATT the use***

PEOU is found to have a significant effect on ATT. The results showed that the path coefficient was ($\beta = .241$, $p < .05$) and, hence, supported hypothesis H2b. These results mean that if rural high school teachers' perceived ease of use increases by one-unit, their perceived attitude towards the use will increase by 0.241. This finding is in agreement with the findings of (Montrieux et al., 2014), who found out that teachers' feeling towards mobile learning is affected by their perceptions of how difficult it is to use mobile learning. This finding is due to rural high school STEM teachers belonging to the "digital immigrants" generation, who struggle to use mobile devices to carry out specific tasks. This was also echoed in the interviews when T2 wrote,

"*As for me typing is a problem*, *I am very slow as a result the use of M-learning will increase the preparation time*."

This shows that rural high school STEM teachers are not proficient mobile devices users, however, they possess minimum skills that enable them to operate the devices. The teachers also highlight the need for thorough training before the implementation of mobile learning.

One commented,

"*We really need training not what the Department usually does*." (T3)

This shows that rural high school STEM teachers welcome the opportunity of being trained to use mobile learning for STEM teaching. It is these minimum skills of operating mobile devices they possess and the opportunity for training to use mobile learning that makes them believe that they will find mobile learning easy to learn. This belief that mobile learning will be easy to learn influences their attitude towards mobile learning.

It could be suggested that for mobile learning to be successfully implemented for STEM teaching in rural areas, educators need to be skilled in how to use it. Furthermore, mobile learning platforms should require minimum effort to learn for STEM teaching.

- ***Hypothesis H1a: ATT the use has a significant effect on BI to use***

Teachers' behavioural intention to use mobile learning was significantly influenced by perceived attitude towards the use (Pynoo & Duyck, 2012). The results of this study were congruent with the findings of Callum et al. (2014). Similar results were also obtained from the study by Odiakaosa et al. (2017), who studied the factors that Namibian teachers consider important when accepting M-learning.

These results show that teachers' attitudes influence their behavioural intention to use mobile learning. This finding means that the adoption of mobile learning by rural high school STEM teachers depends on their feeling towards mobile learning. It is interesting to note that only teachers' perceived attitudes towards the use directly influenced their behavioural intention. These findings confirm the studies of El-Gayar and Moran (2007), Montrieux et al. (2014) and Anderson et al. (2006), who collectively emphasized the importance of managing teachers' attitudes towards mobile learning. All the other factors' influence on behavioural intention were mediated by perceived attitude towards the use. What can be learnt from this finding is that for mobile learning to be fully implemented for STEM learning in rural areas, teachers should have positive feelings towards it.

The interviews revealed that rural high STEM teachers' positive attitude towards mobile learning was caused by their belief that mobile learning will improve the learners' performance in STEM-related subjects. (T1) wrote,

"*With high failure rate in Mathematics and Science in this area*, *I think its high time M-learning is introduced because it is going to improve the pass rate for these problematics subjects*".

This shows that rural high school STEM teachers believe that mobile learning will improve learners' performance in STEM-related subjects. It is the belief that mobile learning will improve learners' performance that causes them to have a positive attitude towards mobile learning. This is because rural STEM teachers who participated in this study were teachers of the examination class, teaching the STEM subjects that are experiencing a high failure rate. Rural high school STEM teachers' perception that mobile learning will improve the pass rate of STEM-related subjects influences their behavioural intention to use M-learning.

- ***Hypothesis H2c: PR has a positive effect on ATT the use***

Hypothesis H2c proposed that rural high school teachers' perceptions on the availability of resources positively influences their perceived attitude towards the use. The findings of the path coefficient show a significant coefficient beta ($\beta = .403$, $p < .05$), thus supporting hypothesis H2c. This implies that an increment on rural high school STEM teachers' perceived resources by one-unit, increases their perceived attitude towards the use by 0.403. This finding is in agreement with the findings of Hamzah and Muchlis (2018), who studied the acceptance of e-learning in Saudi Arabia. Hamzah and Muchlis (2018) reported that the unavailability of resources influenced teachers' perceived attitude towards M-learning.

Unlike the results of the study by Hamzah and Muchlis (2018), the results of this study reveal that rural high school STEM teacher have devices and an internet connection can support mobile learning. Teachers also reported that some schools have Wi-Fi and tablets that were donated to them. (T2) stated that,

"*There is a Wi-Fi router and 20 tablets that were supplied by Vodacom*, *but there are locked inside the saferoom*."

It is this availability of these little resources that influence rural high school STEM teachers' attitudes towards mobile learning.

- ***Hypothesis H2a: PU will have a positive direct effect on ATT the use***

Hypothesis H2a proposed that rural high school STEM teachers' belief that using mobile learning could improve their performance in teaching STEM will positively affect their attitude towards using mobile learning. The standardized path coefficient showed a significant result ($\beta = .226$, $p <.05$). This means that rural high school teachers' perceived attitude towards the use will increase by 0.226 if their perceived usefulness increases by one-unit. This showed that rural high school STEM teachers' belief that using mobile learning will enhance their teaching, positively influences their feeling towards the use of mobile learning. The interviews revealed that all teachers agreed that mobile learning has the potential of improving learners' STEM performance. Another teacher wrote, "*With high failure rates in Mathematics and Science in this area*, *I think its high time M-learning is introduced because it is going to improve the pass rate for these problematics subjects*" (T1).

This shows that rural high school teachers perceived that M-learning can improve their learners' performance in STEM-related subjects.

Teachers stated that due to the high rate of absenteeism, teachers will be able to send study materials of the content covered when the learner was not present. This was revealed by (T2) who stated,

"*M-learning will help to reduce time lost*, *due to these social grants collection days. You just cover a lot of content a day before and sent it to them as homework*." (T2).

The ability of mobile learning to reduce the time lost due to absenteeism and teachers' belief that mobile learning will improve learners' performance, influences rural high school STEM teachers' attitudes towards M-learning.

7.4 The Effects of Predictors on Parents of Rural High School STEM Learners' BI to Allow Their Children to Use M-learning

This objective aimed to investigate the factors that affect the behavioural intention of parents of rural high school STEM learners to allow their children to use mobile learning. Based on the SASTAM model proposed in Chapter 3, the hypotheses were then tested in chapter 5 section 5.5.3.2. This section discusses the results.

The results showed that the R-squared values of perceived attitude towards and behavioural intention were 0.423 and 0.379 respectively; these R-squared values were considered to be of moderate strength. In contrast, the R-squared values of PU and PEOU were 0.150 and 0.178 respectively and are considered weak (Chin, 1998). The parents' acceptance mobile learning model explained 37.9% of rural high school STEM learners' parents' behavioural intention to allow their children to use mobile learning. This means that the combined effect of predictors, PEOU, PU, PR, ATT, and

PSI in explaining the behavioural intention of parents of rural high school STEM learners to allow their children to use mobile learning was 37.9%.

Nine hypotheses were not significant and were removed from the final parents' model. The none-significant paths were: PEOU to BI, PPR to ATT, PPR to PEOU, PPR to PU, PR to ATT, PSI to PEOU, PU to BI, and PSR to PEOU. Even though perceived skills readiness strongly positively influenced perceived psychological readiness ($\beta = .567$, $p < .05$), they were both removed from the model because perceived psychological readiness had an insignificant effect on perceived attitude towards the use ($\beta = .045$, $p > .05$), perceived ease of use ($\beta = .024$, $p > .05$) and perceived usefulness ($\beta = .050$, $p > .05$).

The following section presents a discussion for each hypothesis that remained on the parents' M-learning acceptance model.

- ***Hypothesis H1a: ATT has a significant effect on BI to use***

With regards to the path between perceived attitude towards the use and behavioural intention to use mobile learning, the results of the current study were contrary to the findings of the study of Genc (2014), who reported that parents' attitudes do not affect their behavioural intention to use mobile learning. The results of the path coefficient in the current study showed a significant coefficient beta ($\beta = .560$, $p < 0.05$). This result means that if parents' perceived attitude increases by one-unit, their behavioural intention will also increase by 0.560. The results of this study mean that parents' behavioural intention to allow their children to use mobile learning is influenced by their feelings towards M-learning.

Parents have mixed feelings towards mobile learning. Some parents have a positive attitude towards mobile learning. Their positive feelings were caused by their belief that mobile learning will improve their children's performance in STEM-related subjects. Another parent wrote, "*I am looking forward for my child to pass*, *the use of technology will make him pass*." (P2).

This shows that rural high school parents believe that mobile learning can improve their children's performance.

The other reason that causes parents to have a positive attitude towards mobile learning is the ability of mobile learning to make learning material easily available. One parent wrote,

"*My child is sharing textbook with other child*, *and they stay very far away from each other making doing homework difficult*." (P3).

This showed that there is a shortage of textbooks and learning materials that leads to learners sharing textbooks in rural high schools. However, parents believe that if mobile learning is introduced, it will ease these shortages of learning materials. It is these beliefs that mobile learning will make learning materials available and mobile learning will improve learners' performance that causes parents to have a positive attitude towards M-learning.

On the contrary, some parents had a negative attitude towards mobile learning. The reasons they discussed showed that they were not familiar with mobile learning. One parent wrote,

"*Teachers will not be coming to school. They will just sent studying material to learners and this will affect their performance*." (P1)

This showed that some parents do not understand how M-learning functions. It is this lack of knowledge that causes parents to have negative attitudes towards mobile learning.

However, both groups of parents want children's performance in STEM-related subjects to improve. This is because the parents who were the participants in this study were the parents of learners who were in an examination class and they were expecting good results from their children. It is this belief that most parents have that mobile learning will improve learners' performance that influences their behavioural intention to allow their children to use M-learning.

- ***Hypothesis H2b: PEOU has a significant effect on ATT the use***

In the current study, the path coefficient between perceived ease of use and perceived attitude towards the use was (β = .590, $p < .05$), and thus supporting hypothesis H2b. The findings of the current study imply that parents' feeling towards mobile learning depend on the effort required by their children to learn to use mobile learning for learning STEM. These results also showed that PEOU predicts ATT, better than PU (β = .560, $p < 0.05$). This showed that rural parents consider the effort needed to learn to use mobile learning more important when adopting it than its utility.

The result of H2b contradicted the finding of Sánchez-Prietoa et al. (2019) and Saroia and Gao (2018), who collectively found that perceived ease of use does not influence perceived attitude towards the use. These findings were due to parents belonging to the 'digital immigrants' generation who struggle to use mobile devices to carry out specific tasks. One parent stated,

"*I think it is going to be easy for my children to use M-learning. They know how to use cell phones better than what I do*." (P3)

This shows that learners who are 'digital natives' are proficient mobile devices users, while parents who are 'digital immigrants' struggle to use mobile devices.

Table 5.21 shows that perceived ease of use has an indirect effect on behavioural intention through perceived attitudes towards. This shows that the degree to which how difficult it is to use mobile learning platform influences parents' acceptance.

Parents stressed that their children are doing matric, and they are only interested in passing, and as a result, they can only accept M-learning if it is easy to use and make their children pass. (P1) wrote,

"*My child is now in grade 12*, *all I want is for him to pass. So, if M-learning is difficult to learn it will take up his time*." (P1).

This shows that some parents were worried about the effort need to learn to use mobile learning. However, most parents agreed that their children can use mobile devices without struggling, and as a result, it is going to be easy for them to learn how to use

M-learning for STEM. This shows that the attitude that parents possess is influenced by how easy they think it will be for their children to learn to use mobile learning.

- ***Hypothesis H3d: PR has a positive effect on PU***

The results of H3d showed that perceived resources had a significant effect on perceived usefulness. This finding contradicted the results found by Ku (2009), who reported that the availability or unavailability of resources does not affect the belief that mobile learning improves learners' performance. The results of this study support H3d ($\beta = .383, p <.05$). These results mean that for every one-unit increase in parents' perceived resources, perceived usefulness will increase by 0.383.

These findings were not surprising due to the rural environment in which the study was carried out. In rural areas, most families live in poverty and rely on social grants (Mboweni, 2014). This was also revealed in the interviews, where parents expressed that their survival depends on child grants and old people' grants. Another parent wrote,

"*Most of us we live on social grants*, *as a result even if we want them to use M-learning we cannot provide them with phones and data*." (P1).

This showed that some families in rural areas live in poverty, they rely on a social grant, as a result they cannot afford to support their children in the use of mobile learning. Mobile learning requires parents to support their children financially, and as a result, the utility of mobile learning depends on the availability of resources. It is suggested that for M-learning to be successfully implemented in rural areas, resources should be provided.

- ***Hypothesis H4e: PR affects PEOU***

Similar to the results of Ku (2009), this study found that perceived resources has a significant effect on perceived ease of use. The results supported H4e with a beta coefficient of ($\beta = .428, p < .05$). This means that if parents' perceived resource increases by one unit, the perceived ease of use will increase by .428. These results imply that parents of rural high school STEM learners believe that their children will find it easy to learn to use mobile learning if the resources are made available. Table 5.21 showed that parents of rural high school learners' perceived resources indirectly affect their behavioural intention to allow their children to use M-learning through their (parents') perceived ease of use and perceived attitude. This shows that the availability of resources influences rural parents' acceptance of M-learning.

Based on these results, perceived resources significantly influence both perceived ease of use and perceived usefulness, which are key to the acceptance of any information system (Davis, 1989). This shows how important the issue of resources is to parents of rural high school STEM learners. A lesson that may be learnt from these results is that the availability of resources is key to the successful implementation of M-learning in rural areas.

- ***Hypothesis H2f: Perceived social influence has a significant effect on perceived attitude towards the use***

The results of H2f indicate that perceived social influence significantly affects attitude. The results supported hypothesis H2f ($\beta = .239$, $p < .05$). The results imply that for every one-unit increase in parents' perceived social influence, their perceived attitude towards the use will increase by 0.239. Table 5.21 also shows that perceived social influence has an indirect effect on PU (though PR), PEOU (though PR) and BI (through PR, PEOU, and ATT). These findings are consistent with the results of the study by Venkatesh et al. (2003).

These results indicate that perceived social influence influences directly or indirectly all the constructs in the TAM model. This shows that parents are not indifferent to what other people (family members and children) say to them about mobile learning. These results suggest that rural parents value what people important to them say about the use of mobile learning for STEM learning. This may be seen in the interview where parents stressed that their children explained to them the benefits of mobile learning for STEM learning. One parent wrote,

"*My child showed me how they can use M-learning to watch other teachers teach the same thing that their teacher was teaching them in class.*" (P1).

This shows that learners influence their parents' perceived attitudes towards the use. This demonstrates that the attitude of parents of rural STEM learners are influenced by what they hear about M-learning from people who are important to them. It can be urged that for M-learning to be successfully implemented in rural areas, there is a need to raise awareness to parents on the benefits of M-learning for STEM education.

- ***Hypothesis H3e: Perceived social influence has a significant effect on perceived usefulness***

It is interesting to note that parents' perceived usefulness had an insignificant effect on their behavioural intention to use ($\beta = .117$, $p > .05$) mobile learning. The results showed that rural high school STEM learner's parents were not acquainted with the usefulness of mobile devices in the classroom. The results also confirmed the finding of Tsuei and Hsu (2019), who found that perceived usefulness indirectly influences users' behavioural intention by the mediation of perceived attitude towards the use. The results also indicate that perceived social influence has a significant effect on perceived usefulness.

The path coefficient for that path was ($\beta = .210$, $p <.05$). This implies that the little knowledge that parents have about the usefulness of mobile learning is because of social influence. This might mean that even though rural parents acquired little knowledge from people around them about the advantages that mobile learning brings into STEM learning, that little knowledge positively influences their belief that mobile learning will improve their children's performance in STEM-related subjects.

The data from the interviews also supported that perceived usefulness is influenced by perceived social influence. Another parent stated that other family members who live in town influence them to allow their children to use M-learning. The parent commented,

"*When they come for weekends or if you visit them*, *their children will be using cell phones for everything*, *from learning to playing games. When you ask their parents why they always say that is how they are learning these days.*" (P3).

This shows that other family members influence parents of rural high school learners' beliefs on the utility of mobile learning. This shows that parents of rural high school STEM learners are positively influenced by other family members to allow their children to use M-learning.

Based on the results of both phases of this research it may be concluded that what other people say about mobile learning to parents of rural high school STEM learners influences their beliefs about the usefulness of mobile learning.

7.5 Is There a Significant Difference Between Rural High School Learners' Acceptance of M-learning and Their Parents' and Teachers' Acceptance?

This objective aimed to investigate if there was a statistical difference between rural high school STEM learners' acceptance of M-learning and their teachers', and parents'. The objective also sought to gain an understanding of the factors that rural high school STEM learners, their teachers and parents consider important when accepting mobile learning. Based on the SASTAM model proposed in Chapter 3, PLS-SEM was used to assess the hypotheses. The SASTAM's structural model given in Figure 5.8 was analysed by assessing the R-squared value (variance explained), structural paths (path coefficient), the effect size (f-squared) and predictive relevance (Q-squared).

The results showed that the SASTAM model adequately explained and can predict BI of rural high school STEM learners', their teachers', and parents' acceptance of mobile learning. The results showed that the R-squared values of PPR, ATT and BI were 0.314, 0.278 and 0.408 respectively; these R-squared are considered to be of moderate strength. The combined contributions of PEN and PSR on perceived psychological readiness was 31.4%, while the combined contribution of the predictors of perceived attitude towards the use was 27.8%. An R-squared value of 0.408 means that all the exogenous construct combined can explain 40.8% of the variance in behavioural intention to use mobile learning. This means that the combined effect of the factors PEOU, PU, PR, ATT, PEN, PSR, PPR, and PSI in explaining rural high school STEM learners', their parents', and teachers' behavioural intention to use mobile learning, was 40.8%.

These results also showed that all the Q-squared values were greater than zero, and this supports the model's predictive relevance regarding the endogenous latent variables (Hair et al, 2014). This implies that the SASTAM model can predict rural high school STEM learners', their parents', and teachers' BI to use mobile learning. In other words, the factors perceived ease of use, perceived usefulness, perceived resources, perceived attitude towards, perceived enjoyment, perceived skills readiness, perceived psychological readiness, and perceived social influence positively affect rural high learners' behavioural intention to use mobile learning.

The results also showed that perceived attitude towards had an effect size (f-squared = 0.4) on behavioural intention, which is a high effect size according to Cohen et al. (2003). The f-squared of perceived attitude was higher than that of perceived usefulness (0.26.) and perceived ease of use (0.243). This means that rural high school learners' perceived attitude towards the use contributes more in their intention to use M-learning than their perceived usefulness and perceived ease of use. Perceived usefulness and perceived ease of use have a medium effect size on behavioural intention (Cohen et al., 2003). This means that, even though the contribution perceived usefulness and perceived ease of use to rural high school STEM learners', their parents' and teachers' behavioural intention are lower than that of perceived attitudes, they still play an important role in predicting behavioural intention to use mobile learning.

The six hypotheses H4e, H3f, H4b, H1c, H3g, and H4d were not significant and they were removed from the SASTAM final model. The following section presents a discussion of the hypotheses that were supported by data.

- ***Hypothesis H1a: Perceived attitude has a significant effect on behavioural intention to use***

Perceived attitude towards was the best factor that explained variances in rural high school STEM learners', their parents', and teachers' intention to adopt mobile learning with the standardised ($\beta = .511$, $p < .05$). This means that their (learners, teachers, and parents) behavioural intention will increase by 0.511 if their perceived attitude towards increases by one-unit. This results are in line with the findings of Zhu et al. (2018), Saroia and Gao (2018) and Al-Emran et al. (2019), who collectively found that perceived attitude predicts behavioural intention to use mobile learning. The results in Table 5.43 also indicated that perceived attitude towards the use functioned as a crucial mediating variable between behavioural intention to use mobile learning and perceived ease of use, perceived usefulness, perceived resources, perceived skills readiness, psychological readiness and perceived social influence. Additionally, contrary to the findings of (Liu et al., 2018; Mohammadi & Mahmoodi, 2019; Yorganci, 2017), this study found that perceived attitude was the major determinant of behavioural intention to use mobile learning. This finding implies that perceived attitude towards the use plays a pivotal role in the acceptance of mobile learning for STEM teaching and learning in rural areas.

Based on the results of this study, and other studies like those of El-Gayar and Moran (2007), Montrieux et al. (2014) and Anderson et al. (2006), it is reasonable to conclude that for M-learning to be successfully implemented for STEM learning in rural areas, parents', learners', and teachers' attitudes need to be positive. It could be suggested that emphasis should be placed on the factors that improve teachers', learners', and parents' attitudes towards M-learning.

The findings reveal that rural high school STEM learners, their teachers and parents were almost unanimous in their agreement that they have intentions to use mobile learning. In their replies to all three questions about their behavioural intention, question BI2 (question with the lowest mean) had a mean of 5.59 with a standard deviation of 1.483 (see Table 5.3). This shows a high average, indicating that they do intend to use mobile learning. In contrast, the question with the lowest mean on perceived attitude towards had a mean of 5.67 and a standard deviation of 1.314, indicating that rural high school STEM learners, their teachers, and parents have a positive attitude towards mobile learning.

- ***Hypotheses H1e: PEOU significantly affects BI.***
  H1c: PU positives influences BI.

The results of 1Hc (β = .169, p <.05) are in agreement with the findings of the studies of (Pramana, 2018; Usagawa & The, 2018), who collectively reported that behavioural intention is positively influenced by perceived usefulness. However, the results of H1e (β = .080, p <.05) are contrary to the findings of Liu et al. (2010), who found that perceived ease of use does not affect behavioural intention. These results support hypotheses H1e and H1c and imply that rural high school STEM learners, their parents, and teachers value the utility and the effort needed to learn to use mobile learning for STEM learning.

However, rural high school STEM learners, their teachers, and parents consider utility (PU) (β = .169, p <.05) more important when accepting M-learning than the effort needed to learn to use it (PEOU) (β = .080, p <.05). The reason for this is caused by the environment in which the study was carried out. This study was conducted in rural areas, where there is a lack of learning material, science laboratories, and science equipment (Makgato, 2007). The benefits that mobile learning brings into the STEM classroom contributes to the acceptance of mobile learning in rural areas.

In contrast, the effect of perceived ease of use on behavioural intention to use mobile learning was influenced by the type of participants. Most participants (teachers and parents) in this study were digital immigrants, who were not experts in the use of mobile devices in their everyday activities. This was revealed in the interviews when one of the teachers wrote,

"*As for me typing is a problem*, *I am very slow as a result the use of M-learning will increase the preparation time*." (T2).

The same remark was also given by parents. One parent wrote,

"I think it is going to be easy for my children to use M-learning. They know how to use cell phones better than what I do." (P3).

This showed that both teachers and parents are not as proficient mobile devices users as learners. Therefore, they consider the effort needed to learn to use mobile learning important when accepting mobile learning.

Table 5.3 also reveals that the question with the lowest mean on perceived usefulness is PU4 with an average of 6.47 and a standard deviation of 0.819. This shows that rural high school STEM learners, their parents, and teachers are almost unanimous in their agreement that M-learning is useful based on their responses to all the five questions.

In contrast, the question with the lowest mean on perceived ease of use had an average mean of 3.67 with a standard deviation of 0.989. This showed that perceived ease of use has a low average. This indicated that most participants had low confidence in the mobile learning skills possessed by both teachers and learners.

Hypotheses H2a: PU will have a positive direct effect on ATT use.

H2b: PEOU has a significant effect on ATT use.

H2f: PSI has a significant effect on ATT use.

H2c: PR has a positive effect on ATT use.

The results of H2a ($B = 0.303$, $p < 0.001$) showed that perceived usefulness affects perceived attitude towards the use. The results confirmed the results of (Li et al., 2019; Yeap et al., 2016), who found that perceived attitude towards is significantly affected by perceived usefulness. The results of the current showed that perceived usefulness was the most significant factor to explain variances in rural high school STEM learners', their parents' and teachers' attitudes towards the use of M-learning with the standardised coefficient ($B = 0.303$, $p < 0.001$). This means that if rural high school STEM learners', their teachers' and parents' perceived usefulness increases by one-unit, their perceived attitude towards the use will increase with 0.303.

The reason why perceived attitude towards of participants was influenced by perceived usefulness was that the participants of the study were parents, teachers and learners of STEM-related subjects which are regarded as difficult (DoE, 2015), and as a result, any tool that could improve learners' performance in STEM-related subjects positively affects the feelings of the users (parents, teacher and learners). This was revealed during the interview sessions when one of the teachers wrote,

"*With high failure rate in mathematics and science in this area*, *I think its high time M-learning is introduced because it is going to improve the pass rate for these problematics subjects*" (T1).

This shows that their belief that mobile learning can improve learners' performance in STEM-related subjects, positively influence their feelings towards M-learning.

Besides considering the usefulness of M-learning, the study also demonstrated that rural high school STEM learners, their parents and teachers also consider the effort needed to learn to use mobile learning platforms. The result of H2b ($B = 0.239$, $p < 0.05$) showed that parents', learners', and teachers' perceived ease of use affected their attitude towards the use of mobile learning for teaching and learning STEM-related subjects. The results supported H2b ($B = 0.239$, $p < 0.05$), which means that for every one-unit increase in rural high school STEM learners', their teachers' and parents' perceived ease of use, their perceived attitude towards the use will increase by 0.239. This implies that the feelings towards mobile learning of rural high school STEM learners, their parents and teachers are influenced by the effort needed to learn to use mobile learning. The results of H2b are contrary to the findings of Sánchez-Prietoa et al. (2019) and Saroia and Gao (2018), who collectively found that perceived attitude the use is not predicted by perceived ease of use.

Perceived attitude was also positively affected by perceived social influence ($\beta = 0.097$, $p < .05$) and perceived resources ($\beta = 0.180$, $p < .05$). These findings support hypotheses H2f and H2c and are consistent with the findings of (Venkatesh et al., 2003), who stressed that people internalise the stories of others and make them their own.

The relationship perceived social influence to perceived attitude had a path coefficient of ($\beta = 0.097$, $p < .05$), which implies that perceived attitude towards the use will increase by 0.097 for every one-unit increase in their perceived social influence. The results mean that rural high school STEM teachers, parents, and learners are not immune to social influence about mobile learning for STEM learning. These results also mean that in rural areas, positive stories about the use of mobile learning for STEM learning positively affect users' feelings towards mobile learning.

Regarding the relationship between perceived resources and perceived attitude towards the use, the results contradict the finding of Ku (2009) and Mathieson et al. (2001), who found that perceived resources does not influence perceived attitude. The results of the current study showed that this relationship between perceived resources and perceived attitude towards the use had a path coefficient of ($\beta = 0.180$, $p < .05$). This means for every one-unit increase in rural high school STEM learners', teachers', and parents' perceived resources, their perceived attitude towards the use increases by 0.180. This finding is not surprising considering the context of the study. This study was carried out in a rural area where most families live in poverty and rely on social grants for their survival (Mboweni, 2014). The availability of mobile learning resources positively affects the attitude of high school STEM learners, their parents, and teachers towards mobile learning.

- ***Hypotheses H4e: PR has a significant effect on PEOU.***
  H3d: PR has a positive effect on PU.

The results also showed that perceived resources not only affect perceived attitude towards the use but, it has a positive significant effect on both perceived ease of use and perceived usefulness. These findings support hypotheses H4e and H3d. The path coefficient between perceived resources and perceived ease of use showed a beta value of ($\beta = 0.282$, $p < .05$), which means a one-unit increase in PR increase will significantly increase PEOU by 0.282 unit. This finding is consistent to the findings of Ku (2009) and Mathieson et al. (2001), who claimed that relationship had beta values of ($\beta = 0.564$, $p < .05$) and ($\beta=0.510$, $p< .05$) respectively. These findings also mean that for rural high school STEM learners, their teachers and parents, the availability of mobile learning resources had a direct effect on how easy it will be to use mobile learning for STEM learning.

Rural high school STEM learners, their teachers, and parents believe that the availability of resources will have a positive effect on their beliefs that using mobile learning could improve their teaching and learning. The path coefficient between perceived resources and perceived usefulness showed a beta value of (β=0.122, p< .05), which means with a one-unit increase of their perceived resources, their perceived usefulness increases by 0.122 units. The results also showed that through perceived usefulness and perceived attitude, perceived resources significantly affect behavioural intention to use mobile learning. This shows that rural high school STEM learners', their parents', and teachers' decision to adopt mobile learning for STEM learning partially depends on the availability of resources.

- ***Hypothesis H3a: PEOU influences PU.***

Perceived ease of use positively affects perceived usefulness. The path had a path coefficient of (β = 0.296, p < .05). This means that rural high school STEM learners', their parents', and teachers' beliefs on whether mobile learning will be easy to learn, will improve their beliefs that using mobile learning could improve their performance in STEM-related subjects. The results indicated that for every one-unit increment in perceived ease of use, perceived usefulness will increase by 0.296. This finding from the current study is contrary to the findings of Sánchez-Prietoa et al. (2019) and Saroia and Gao (2018), who reported that perceived ease of use does not affect perceived usefulness.

Table 5.43 showed that perceived ease of use significantly influences rural high school STEM learners', their parents' and teachers' behavioural intention through perceived usefulness and perceived attitude towards. Based on the results of this study, it may be concluded that the belief that it will be easy to use mobile learning for STEM learning, contributes to the adoption of mobile learning in rural areas for STEM learning.

- ***Hypotheses H3c: PPR has a significant effect on PU.***
  H5d: PSR has a positive effect on PPR.
  H5c: PEN has a positive effect on PPR

Perceived psychological readiness is positively influenced by perceived skills readiness. This implies that rural high school STEM learners and teachers who have confidence in their ability to use mobile devices to carry out specific tasks believe that there are psychologically ready for M-learning. The path coefficient was $\beta = .503$ ($p < .000$), which means that if perceived skills readiness increases by one unit, perceived psychological readiness will improve by 0.503. The results of H5d are in agreement with the finding of Erlich, Erlich-Philip, and Gal-Ezer (2005), who reported that learners who are not familiar with using computers before registering for an online course reported more frustration and anxiety compared to those who were used to computers. Table 5b shows that on the construct perceived skills readiness, the question with the lowest average PS3 had a mean of 3.90 with a standard deviation of 1.250. This low average indicates that rural high school STEM learners and their teachers were not confident in their ability to use M-learning.

The results of H3c also showed that perceived psychological readiness positively influences perceived usefulness. The coefficient of this path was ($\beta = 0.096$, $p < 0.05$). This means for every one-unit increase in perceived psychological readiness, perceived usefulness will increase by 0.096. This implies that rural high school STEM learners', their parents' and teachers' belief in their psychological readiness influence their beliefs on the utility of mobile learning. Based on these results, one can conclude that teachers and learners need to get training on using mobile learning for STEM learning. When they have confidence in their ability to use mobile learning, their psychological readiness will become positive and this in turn positively influence their perception of the utility of mobile learning.

The results of H5c showed that perceived enjoyment positively influenced perceived psychological readiness. The coefficient of this path was ($\beta = 0.145$, $p < 0.05$), which means that if perceived enjoyment increases by one unit, perceived psychological readiness will improve by 0.145. This implies that learners and teachers who enjoy using mobile devices will enjoy using the same devices for teaching and learning. The reason for this finding is that teachers and learners who enjoy using mobile devices are proficient mobile devices users, as a result they are mentally ready to use the devices for teaching and learning.

To answer research question 4 (Are there statistical differences between rural high school STEM grade 12 learners' acceptance and their parents and teachers?) the parametric and Welch-Satterthwait tests were used. The results showed that for learners and parents, only three path coefficients were statistically different. These paths are PEOU to ATT, PR to PEOU and PSI to ATT. This was calculated by subtracting parents' coefficient from that of the learners' coefficient. The results are positive for all the paths, meaning that learners' relationships on the paths are stronger than those of their parents.

It is interesting to note that learners had a stronger path coefficient on the relationship between perceived ease of use and perceived attitude towards the use. This confirms the finding of (Zhu et al., 2018), who also found that learners possess more positive attitudes towards tablets than their parents. This was also echoed in learners' interviews. Learners highlighted the fact that some of their parents do not trust them to use mobile learning. They also revealed that some parents associate mobile devices with social networks. L1 stated,

"*If our parents see us on cell phones*, *they automatically think that were busy with WhatsApp and that*." (L1).

This shows that parents have some concerns with the use of mobile devices for STEM learning. This shows that even though parents had a positive attitude towards mobile learning, it was not as positive as their children's.

The results showed that learners' relationship between PR and PEOU was stronger than their parents. This was because most learners own or have access to mobile devices, and they are proficient users of these devices. This was revealed in the interview by L3 who wrote,

"*Our friends do kind of promote because they kind of understand and most of them are using it anywhere*."

This shows that most learners have mobile devices and they are already using the devices. Consequently, the relationship between perceived resources to perceived ease of use was higher than their parents. In contrast, their relationship between perceived social influence and perceived attitude towards the use was stronger than that of their parents. A sensible reason for that can be derived from the aforementioned comment by L3 that other learners are already using mobile devices for learning and they are benefiting a lot. This shows that learners hear more positive things about mobile learning than their parents. This strengthens the relationship between what they hear from other learners and their feelings towards mobile learning.

The parametric and Welch-Satterthwait tests were also used to test if there was a significant difference between rural high school STEM grade 12 STEM learners' and their teachers' acceptance models. The results showed that only one path (PR to ATT) was significantly different. This was calculated by subtracting teachers' path coefficients from that of learners' coefficient. The results showed a positive answer, meaning that the learners' path coefficient was greater than their teachers'. This implied learners' perceived attitude towards was greatly influenced by the availability of resources more than their teachers. This may be attributed to the fact that learners had a more positive attitude towards mobile learning than their teachers. As a result, the availability of limited resources (devices and internet) influences learners to have a positive attitude towards mobile learning more than their teachers.

The Welch-Satterthwait test was used to test if there is a significant difference between parents and teachers' acceptance model. The results showed that teachers' path coefficients were higher than the parents' path. The results also revealed that for the paths perceived ease of use to perceived attitude towards and perceived resources to perceived attitude towards the use, there was a statistical difference between teachers and parents' path coefficients. The results imply that for parents the belief that their children will find mobile learning easy to use influence their attitude towards mobile learning better than teachers. A sensible reason for that finding is parents know that children can use mobile devices effortless hence using the same devices for learning will be easy. On the other hand, teachers are not confident in their skills of using mobile learning and hence their belief that they will find it easy to use mobile learning is not as strong as parents' belief that their children will find mobile learning easy to use.

Generally, the results showed that even though learners' path coefficients were higher than that of their parents and teachers, all the path coefficients were positive and significant for all the groups. The results also revealed that even though the teachers path coefficients were higher than parents', the path was significant for both groups. This means that the same model (SASTAM) can be used to predict the acceptance of M-learning by all the three groups. Tables 7.1a, b and c present a summary of the findings that were presented in this chapter.

Table 7.1a: Summary of the results

Theme	Factors resolutions			
	Learners	Teachers	Parents	Combined
Behavioural intention	Behavioural intention was predicted by perceived attitude towards, perceived usefulness, perceived ease of use, and perceived social influence.	Behavioural intention was predicted by perceived attitude towards.	Behavioural intention was predicted by perceived attitude towards.	Behavioural intention was predicted by perceived attitude, perceived usefulness, and perceived ease of use.
Perceived attitude towards	Perceived attitude towards was predicted by perceived usefulness and perceived resources.	Perceived attitude was influenced by perceived usefulness, perceived ease of use, and perceived social influence.	Perceived attitude was influenced by perceived usefulness, perceived ease of use, and perceived social influence.	Perceived attitude was predicted by perceived usefulness, perceived ease of use, perceived resources, and perceived social influence.
Perceived usefulness	Perceived usefulness was by influenced by perceived ease of use.	Perceived usefulness influenced perceived attitude. Perceived ease of use, perceived resources, and perceived social influence predicted perceived usefulness	Perceived usefulness was influenced by perceived resources and perceived social influence.	Perceived usefulness was predicted by perceived ease of use, perceived psychological readiness, and perceived resources.

Table 7.1b: Summary of the results continued

Theme	Factors resolutions			
	Learners	Teachers	Parents	Combined
Perceived psychological readiness				Perceived psychological readiness was predicted by perceived enjoyment and perceived skills readiness
Perceived enjoyment				Perceived enjoyment predicted perceived psychological readiness
Perceived social influence	Perceived social influence predicted behavioural intention.	Perceived social influence predicted perceived usefulness and perceived attitude towards	Perceived social influence predicted perceived usefulness and perceived attitudes towards.	Perceived social influence predicted perceived attitude towards.
Perceived skills readiness				Perceived skills readiness predicted perceived psychological readiness.
Perceived ease to collaborate				

Table 7.1c: Summary of the results continued

Theme	**Factors resolutions**			
	Learners	Learners	Teachers	Parents
Perceived ease of use	Perceived ease of use was influenced by perceived resources.	Perceived ease of use predicted perceived attitude. Perceived resources predicted perceived ease of use	Perceived ease of use was influenced by perceived resources.	Perceived ease of use was predicted by perceived resources.
Perceived resources	Perceived resources predicted perceived ease of use and perceived attitude towards.	Perceived resources influenced perceived usefulness and perceived ease of use.	Perceived resources predicted perceived ease of use and perceived usefulness.	Perceived resources predicted perceived ease of use, perceived usefulness, and perceived attitude towards.

7.6 Summary

Four factors (ATT, PEOU, PU, and PSI) are found to directly affect rural high STEM learners' behavioural intention to use M-learning. Perceived attitude is found to be the best predictor of learners' behavioural intention to accept learning STEM using M-learning. Although learners' attitude towards the use of mobile learning was positive, more needs to be done to improve their attitude. When accepting M-learning, rural high school STEM learners value easy to use mobile learning platforms with more learning materials and assessments. It is also important to raise awareness among learners on the benefits of using mobile learning for STEM learning.

Rural high school STEM teachers' behavioural intention to accept mobile learning was directly influenced by perceived attitude only. Although teachers have a positive attitude towards M-learning, more can still be done to improve it. The benefits of incorporating mobile learning into STEM teaching was welcomed by teachers, although more could be done by the DoE, in terms of raising awareness, provide resources and training. If this is achieved teachers will easily accept and adopt mobile learning for teaching STEM-related subjects.

Like rural high school teachers, parents of rural high school STEM learners' behavioural intention to use mobile learning was influenced by their perceived attitude towards the use only. Their perceived attitude towards the use was influenced by their perceived ease of use, perceived resources, and perceived usefulness. For parents, the effort required to learn to use mobile learning is more important to them than the utility and the availability of resources. For parents to allow their children to use mobile learning, it is important that their children are provided with resources and training to utilise mobile learning for STEM learning.

Rural high school learners possess more of positive attitude towards mobile learning as compared to their teachers and parents. Even though learners had more positive attitude towards mobile learning than their teachers', it is only the relationship between perceived resources and perceived attitude that is statistically different. Thus, the acceptance of M-learning for both teachers and learners can be explained by the same model (SASTAM). Parents had a less positive attitude towards the use of M-learning than their children's. However, their acceptance of M-learning can be predicted by the same model (SASTAM); this was because only three paths of the model were significantly different from each other. The paths which were different are PEOU to ATT the use, PR to PEOU and PSI to ATT the use.

In the next chapter, the recommendations that address these issues are outlined, both in terms of strategies that could be useful for a successful implementation of M-learning in South African rural high schools, and suggestions for further study.

CHAPTER 8 CONTRIBUTION, IMPLICATIONS, RECOMMENDATIONS AND CONCLUSIONS

8.1 Introduction

This chapter explored the implications of the results of the current study, both in terms of the limitations of this study, and what its implications on the understanding of the mobile learning acceptance by rural high school STEM learners, their teachers, and parents in South Africa. Recommendations were made on what could be done by the DoE for the successful implementation of mobile learning in rural high schools. Finally, the chapter offered suggestions on the direction that further research on aspects of the subject might take both in South Africa and other African countries.

8.2 Contributions of the Study

8.2.1 Theoretical Contribution

By proposing and empirically testing SASTAM, this study has contributed to theory-building in the field of technology acceptance, particularly in an educational context. Specifically, this study provided external factors that can be added to the Technology Acceptance Model to predict mobile learning acceptance by high school STEM learners, their teachers, and parents in a rural context. The study provided some insights into causal relationships among the added external factors and the Technology Acceptance Model. The contributions of SASTAM to TAM are detailed below.

Contribution 1: This study has developed and empirically tested the SASTAM to come up with a model that can be used to predict STEM learners' acceptance of mobile learning (learners' acceptance of mobile learning model) in a rural context. Learners' acceptance of mobile learning model has provided some understanding that perceived social influence and perceived resources can be added to Technology Acceptance Model to predict mobile learning acceptance. Perceived social influence has a direct positive effect on users' behavioural intention to use M-learning.

In a rural context, perceived resources has a positive direct effect on perceived ease of use and perceived usefulness. Perceive resources has an indirect influence on behavioural intention through perceive attitude towards the use. Learners' acceptance of mobile can be used in South Africa and other developing countries to help decision-makers, such as the DoE, in developing strategies to successfully implement mobile learning.

Contribution 2: The SASTAM was also evaluated using data collected from rural STEM teachers to come up with the teachers' acceptance of mobile learning model. The teachers' acceptance of mobile learning model provided additional information that perceived resources could be used to extend the Technology Acceptance Model to predict teachers' mobile learning acceptance. Even though Ku (2009) investigated the online learning system by adding perceived resources to Technology Acceptance Model, the implications related to resource issues only addressed the students' belief in the availability of resources provided by the university.

In this current study, perceived resources was considered in a rural context where mobile learning resources are limited and are not provided. The resources referred to in this study were the availability of mobile devices, internet connection, and mobile data. Perceived resources had a direct effect on perceived attitude towards the use and an indirect effect on behavioural intention. The DoE can use this model to come up with policies and strategies for the adoption of mobile learning by teachers in a rural context. The model could usefully be applied in similar contexts, such as to other developing countries.

Contribution 3: The study also provided information on the factors that parents of rural STEM learners consider important when accepting M-learning. The SASTAM was evaluated using data collected from parents of rural STEM learners. The results provide some insights that perceived resources and perceived social influence can be used to extend Technology Acceptance Model. Perceived resources had a direct positive influence on Technology Acceptance Model's two main pillars (perceived usefulness and perceived ease of use). Perceived ease of use and perceived attitude mediated the effect of perceived resources on behavioural intention. Perceived social influence had a direct effect on perceived attitude and perceived usefulness. The relationship between perceived social influence and behavioural intention was mediated by the perceived attitude towards the use. This model can help the ministries of education in developing countries to make informed decisions on incorporating parents' needs to successfully implement M-learning.

Contribution 4: The original Technology Acceptance Model was extended by adding factors that are educationally context related. Factors such as perceived resources, perceived social influence, perceived psychological readiness, and perceived skills readiness, indirectly affect rural high school learners', their teachers', and parents' behavioural intention to use M-learning. This study also revealed that external variables that are context-related can be used to extend the original Technology Acceptance Model. This is useful for developing other conceptual frameworks for exploring technology adoption within educational contexts.

Contribution 5: The study revealed that perceived social influence and perceived resources were the most consistent significant external variable in all the four models developed. This implies that perceived resources and perceived social influence are the most important external TAM variables and should be included when predicting the acceptance of mobile learning in a rural context.

8.2.2 Practical Contribution

In practical terms, this study has also helped in understanding the factors that can promote or impede the successful implementation of mobile learning in South Africa. These factors can assist the DoE, mobile developers, and teacher training institutions on how to successfully implement mobile learning. This applies in particular to the context of African countries and other developing countries where the situation in their secondary schools is congruent to that of South Africa. The individual contributions are detailed.

Contribution 6: This study discovered perceived resources plays a vital role in the acceptance of mobile learning by having a positive influence in all the original Technology Acceptance Model's (perceived ease of use, perceived attitude towards and perceived usefulness) antecedence of behavioural intention to use mobile learning. These findings are useful to the DoE concerning the kind, quality of infrastructure and technical support that is needed in rural areas to successfully implement mobile learning. The DoE should supply tablets and laptops to both teachers and learners. Wi-Fi and/or off-line portals should also be supplied in rural schools to support M-learning. This is especially true in the case of Africa and other developing nations.

Contribution 7: The study discovered that perceived social influence plays an important role in mobile learning acceptance in rural areas. This finding is important for the DoE, in that rural communities, need awareness programs for mobile learning to be successfully adopted.

Contribution 8: To date, there have not been any studies of mobile learning acceptance in South Africa secondary education that have concentrated on the perspective of teachers, learners, and parents. Given the details provided by parents, learners and teachers in their interviews and a large survey sample size, this research provided a comprehensive picture of rural high school learners', their parents', and teachers' behavioural intention to accept mobile learning. The study showed that rural high school STEM learners, their teachers, and parents have a positive attitude towards mobile learning. The study also revealed the importance of perceived resources and perceived social influence on the acceptance of mobile learning.

8.2.3 Methodological Implications of the Study

Contribution 9: Data that were collected from rural STEM learners, their teachers and parents was combined and used to test and evaluate the SASTAM. This was done to give an overall picture of mobile learning acceptance in a rural context. The study provides some information that perceive psychological readiness, perceived skills readiness, perceived social influence and perceived resources can be added to the Technology Acceptance Model to predict mobile learning acceptance in rural areas. Perceived skills readiness and perceived enjoyment have a direct effect on perceived psychological readiness, which in turn influences perceived usefulness. Perceived resources influences all the Technology Acceptance Model predictors (perceived usefulness, perceived attitude, and perceived ease of use) of behavioural intention. In contrast, perceived social influence had a direct effect on perceived attitude towards the use and an indirect effect on behavioural intention. In a rural context, parents, learners, and teachers consider perceive psychological readiness, perceived skills readiness, perceived social influence and perceived resources important when accepting mobile learning.

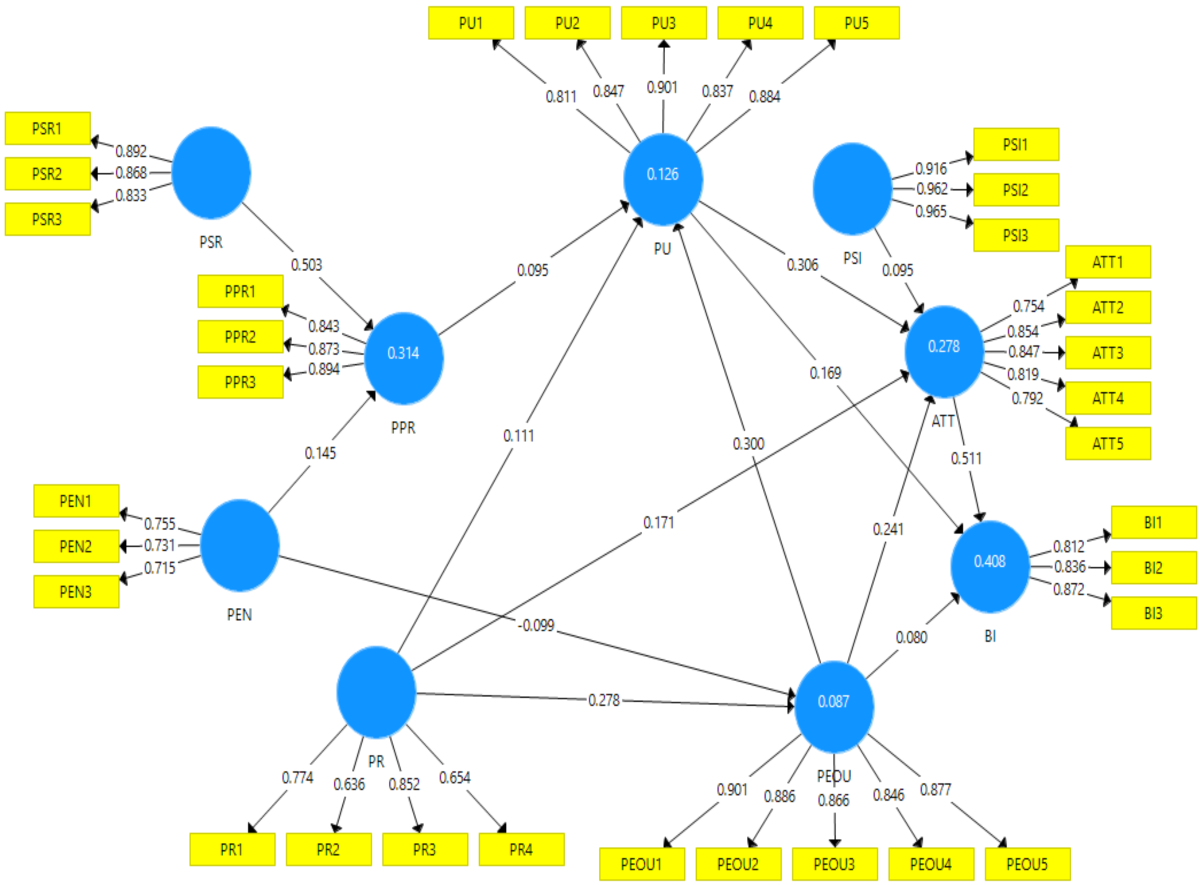


Figure 8.1: SASTAM model

This model can be used by the DoE to come up with strategies to successfully implement M-learning. The model could also help in a similar context, such as other African countries.

8.3 Limitations of the Study

The results of this research need to be considered in light of its limitations:

- The study was only limited to rural high schools. To get a clearer picture of the acceptance, both rural and urban areas of South Africa should be considered.

- Only grade 12 learners, their teachers, and parents were the participants in this study. Generalising the findings of this study to all classes of rural high school should be done with caution.
- Only STEM learners, their teachers, and parents were considered in this study, meaning that generalising the findings of the research to other departments, such as commerce and humanities classes, should be carefully done.
- The study focused on one district (King Cetshwayo), hence the generalisation of these results to other districts should be done with caution.
- The study was conducted in rural schools that had not implemented mobile learning. Rural high school STEM learners, their parents, and teachers used their basic knowledge and perceptions about mobile learning to answer questions. This issue might have affected the outcomes of this research.
- In the rural King Cetshwayo District, mobile learning system was not in use, and this study did not investigate the actual use of mobile learning; it depended on the prediction of the use.
- Only female parents were interviewed. Balancing gender when doing research is always advisable.

8.4 Recommendations

Overall, rural high school STEM learners, their teachers, and parents were willing to use mobile learning. This calls for researchers in the mobile learning field to endeavour to adapt this technology in teaching and learning methods.

- It is recommended that technical infrastructure should be put in rural high schools to assist teachers and learners to teach and learn via mobile devices.
- Mobile devices should also be provided to both teachers and learners.
- It is advisable to provide rural parents, learners, and teachers with more information about the benefits of mobile learning using training workshops. Teachers', learners', and parents' feelings towards mobile learning are influenced by what they hear from people important to them.
- Training courses should be organised for in-service teachers to equip them with the skills needed to integrate mobile learning. Teachers consider the effort needed to learn to use mobile learning important when accepting it.

- Network providers should improve network connections in rural areas to support mobile learning. Currently, there are network connections challenges in rural areas
- The DoE should partner with cellular network providers to make mobile learning platforms free and explore the option of off-line portals. This would reduce the burden of mobile data cost, as perceived resources predict behavioural intention to use M-learning.
- Mobile developers should develop mobile learning platforms that are as user-friendly as possible. The effort needed to learn and to be skilful in using mobile learning (perceived ease of use) explains learners', teachers', and parents' behavioural intention to accept mobile learning.
- Mobile developers should develop mobile learning platforms with as much learning and assessment materials as possible; this is because learners and teachers consider the usefulness important when accepting mobile learning.
- Teacher training institutions should provide pre-service teachers with the skills needed to integrate mobile learning in their teaching so that when they join the schools, they will be able to use mobile learning and also help other educators to use it in their teaching.

8.5 Future Work

The following are some suggestions for future research on the area of implementing mobile learning in rural high schools:

- As the results of this study and other studies (Li et al., 2019; Saroia & Gao, 2018; Yeap et al., 2016; Yeop et al., 2019; Zhu et al., 2018) which have highlighted that perceived attitude is key to the acceptance of mobile learning, future studies could focus on teachers' and parents' attitudinal change. This will improve mobile learning acceptance and adoption
- As the current study focused on rural high schools only, future studies can replicate the study in urban areas and compare the results.
- As demonstrated in the study by Zalah (2018a), that demographic information affects acceptance, future studies could test the mediating effect of demographic information on the models.

- To get a clear picture of the acceptance of mobile learning, all learners, parents, and teachers should be considered. Future research could replicate the same study in the same environment, including all high school grades, and the education department.
- Future studies might validate learners' technology acceptance model, teachers' technology acceptance model parents' technology acceptance model and South African Schools' Technology Acceptance Model in different settings and then compare the results.
- It would be interesting to investigate the effect of visualised experiments on learners' performance.
- Future studies could also assess the actual effects of mobile learning on STEM-related subjects in rural areas.
- Future studies could start by acquainting teachers, learners, and parents to mobile learning and adding the actual use on the models.

8.6 Conclusion

This research has established that, despite network connection, lack of resources and lack of training, rural high school STEM learners, their teachers and parents have a positive attitude towards mobile learning. Rural high school STEM learners and their teachers believe that mobile learning would improve their STEM teaching and learning. The conceptual framework (SASTAM) has demonstrated that perceived attitude is the most important factor that rural high school learners, their teachers and parents consider when accepting mobile learning. For mobile learning to be successfully implemented in rural areas, learners, their teachers, and parents should have a positive attitude towards it. Furthermore, perceived resources have been found to influence all the antecedents of behavioural intention to use mobile learning. For mobile learning to be successfully implemented resources should be provided.

This study has highlighted that rural high school STEM learners, their teachers and parents value what they hear about mobile learning from people important to them. There is a need for workshops to educate rural high school stakeholders on the benefits of mobile learning. Additionally, the belief that the use of mobile learning will improve teachers' and learners' performance is important to learners, parents, and teachers in rural areas. Perceived ease of use also influences the behavioural intention of rural high school learners, teachers, and parents to use mobile learning. It is important for mobile learning platforms to be user-friendly and contain as much learning and assessment materials as possible.

The study also highlighted that the attitude towards mobile learning of learners was higher than the attitude of their teachers and parents, but, however, the same model (SASTAM) can be used to predict the acceptance of mobile learning for all the groups. It is hoped that the suggested recommendations may be useful for the successful implementations of mobile learning in South African rural areas. The recommendations could be used by the DoE to come up with mobile learning policies and platforms that will be accepted by both teachers and learners.

REFERENCES

Abdall, H. M. E. & Hegazi, M. O. A. (2014). Mobile learning aspects and readiness. *International Journal of Computer Applications*, 103(11), 22-28.

Abu-al-aish, A. (2014). Toward mobile learning deployment in higher education. Doctor of Philosophy, Brunel University.

Aburub, F. & Alnawas, I. (2019). A new integrated model to explore factors that influence adoption of mobile learning in higher education: An empirical investigation. *Educational and information Technologies, 24, 2145–2158 (2019). https://doi.org/10.1007/s10639-019-09862-x*

Adams, D. A., Nelson, R. R. & Todd, P. A. (1992). Perceived usefulness, ease of use, and usage of information technology: *MIS Quarterly*, 16(2),255-269.

Agarwal, R. & Prasad, J. (1997). Are individual differences germane to the acceptance of new information technologies? *Decision Sciences*, *30(2)*, 361-391.

Agarwal, R. & Prasad, J. (1998). The antecedents and consequences of user perceptions in information technology doption. *Decision Support Systems*, *22(1)*, 15-29.

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, *50(2, 179-211*.

Ajzen, I. & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior.*, Englewood Cliffs: Prentice Hall.

Ajzen, I. & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. *Journal of Experimental Social Psychology*, *22(5)*, *453-474.*

Akour, H. (2009). Determinants of mobile learning acceptance: An empirical Investigation in Higher education. Doctor of Philosophy, Oklahoma State University.

Al-Adwan, A. S., Al-Adwan, A. & Berger, H. (2018). Solving the mystery of mobile learning adoption in higher education. *International Journal of Mobile Communications*, *16(1)*, 24-49.

Al-Adwan, A. S., Al-Madadha, A. & Zvirzdinaite, Z. (2018). Modeling students' readiness to adopt mobile learning in higher education: An Emperical Study. *International Review of Research in Open and Distance Learning*, *19(1), 25-39*.

Al-Emran, M., Alkhoudary, Y. A., Mezhuyev, V. & Al-Emran, M. (2019). Students and educators attitudes towards the use of mlearning gender and smartphone ownership differences. *International Journal of Interactive Mobile Technologies (iJIM)*, *13*, 127-135.

Al-Emran, M. & Salloum, S. A. (2017). Students' attitudes towards the use of mobile technologies in e-Evaluation. *International Journal of Interactive Mobile Technologies*, *11(5)*, 195–202.

Al-Fahad, F. N. (2009). Students' attitudes and perceptions towards the effectiveness of mobile learning in King Saud University, Saudi Arabia. *The Turkish Online Journal of Educational Technology*, *8(2), 34-46*.

Al-Mashhadani, M. A. & Al-Rawe, M. F. (2018). The future role of mobile learning and smartphones applications in the Iraqi private universities. *Smart Learning Environments*, *5(2), 433-451*.

Aldheleai, Y. M., Baki, R., Tasir, Z. & Alrahmi, W. (2019). What hinders the use of ICT among academic staff at Yemen's public universities? *International Journal of Humanities and Innovation (IJHI)*, 2(1), 13-24

Aldunate, R. & Nussbaum, M. (2013). Teacher adoption of technology. *Computers in Human Behavior*, *29(3)*, 519–524.

Alenezi, A., Karim, A. & Veloo, A. (2010). An empirical investigation into the role of enjoyment, computer anxiety, computer self-efficacy and internet experience in influencing the students' intention to use e-learning: a case study from Saudi Arabian governmental universities. *The Turkish Online Journal of Educational Technology*, *9(2)*, 22–35.

Alhassan, R. (2016). Mobile learning as a method of ubiquitous learning: students' attitudes, readiness, and possible barriers to implementation in higher education. *Journal of Education and Learning*, *5(1),188-199.*

Ali, R. & Arshad, M. (2016). Perspectives of students’ behavior towards mobile learning (M-learning) in Egypt: an extension of the UTAUT model. *Engineering, Technology & Applied Science Research*, *6(4)*, 1109-1114.

Almaiah, M., Jalil, M. & Man, M. (2016). Empirical investigation to explore factors that achieve high quality of mobile learning system based on students’ perspectives. *Engineering Science and Technology*, *an International Journal, 5(1), 176-189*.

Almasri, A. K. M. (2014). The influence on mobile learning based on Technology Acceptance Model (TAM), Mobile Readiness (MR) and Perceived Interaction (PI) for Higher Education Students *International Journal of Technical Research and Applications*, *2(2)*, 5-11.

Alotaibi, S. & Wald, M. (2014). Discussion and evaluation of the updated utaut model in IAMSs. *Journal of Intelligent Computing Research (IJICR)*, 5(2), 1-10.

Alrajawy, I., Norzaidi, M. D., Isaac, O. & Mutahar, A. M. (2017). Examine factors influencing the intention to use mobile learning in Yemen Public Universities. *Asian Journal of Information Technology*, 16(2), 287–297.

Alrasheedi, M. & Capretz, L. F. (2015). Determination of critical success factors affecting mobile learning: a meta-analysis approach. *Turkish Online Journal of Educational Technology*, *14(2)*, 41-51.

Alshmrany, S. & Wilkinson, B. (2017). Factors influencing the adoption of ict by teachers in primary schools in Saudi Arabia: Teachers’ perspectives of the integration of ict in primary education. *International Journal of Advanced Computer Science and Applications (IJACSA)*, *8(12)*, 143-156.

Alvarez, M., Torres, A., Rodriguez, E., Padilla, S. & Rodrigo, M. J. (2013). Attitudes and parenting dimensions in parents’ regulation of internet use by primary and secondary school children. *Computers & Education*, *67*, 69–78.

Alzaza, N. S. & Yaakub, A. R. (2011). Students' awareness and requirements of mobile learning services in the higher education environment. *American Journal of Economics and Business Administration*, *3(1)*, 95-100.

Anderson, G. (1990). *Fundaments of educational research*, London: The Falmer Press.

Anderson, J. E., Schwager, P. H. & Kerns, R. L. (2006). The Drivers for Acceptance of Tablet PCs by Faculty in a College of Business. *Journal of Information Systems Education*, *17(1)*, 429-441.

Angeli, C. (2003). Transforming a teacher education method course through technology: Effects on preservice teachers' technology competency. *Computers & Education*, *41(1)*, 19-37.

Ardi, P. (2017). Promoting learner autonomy through Schoology M-learning platform in an EAP class at an Indonesian University. *Teaching English with Technology*, *17(2)*, 55–76.

Aulamie, A. A. (2013). Enhanced Technology Acceptance Model to explain and predict learners' behavioural intentions in learning management systems. Doctor of Philosophy, University of Bedfordshire.

Azjen, I., Brown, T. C. & Carvajal, F. (2004). Explaining the discrepancy between intentions and actions: The case of hypothetical bias in contingent valuation. *Personality and Social Psychology Bulletin*, *30(9)*, 1108-21.

Baek, Y., Zhang, H. & Yun, S. (2017). Teachers' attitudes toward mobile learning in Korea. *The Turkish Online Journal of Educational Technology*, *16(1), 1-13*.

Bandura, A., Adams, N. E., Hardy, A. B. & Howells, G. N. (1980. Tests of the generality of self-efficacy theory. *Cognitive Therapy and Research*, *4(1)*, 39-66.

Baran, E. (2014). A review of research on mobile learning in teacher education. *Educational Technology & Society*, *17*, 17–32.

Barclay, D., Higgins, C. & Thompson, R. (1995). The partial least square (PLS) approach to causal modelling: Personal computer adoption and use as an illustration. *Technology Studies*, *2*, 285-309.

Bartlett, J., Kotrlik, J. & Higgins, C. (2001). Organizational research: Determining appropriate sample Size in survey research. *Information Technology*, *Learning*, *and Performance Journal*, *19(1)*, 43-50.

Bazelais , P. & Doleck, T. (2018). Investigating the impact of blended learning on academic performance in a first semester college physics course. *Journal of Computer Education*, 5(1), 343-354.

Becta (2008). *Harnessing Technology: Schools Survey 2008*. Retrieved from https://dera.ioe.ac.uk/1550/1/becta_2008_htssdata_report.pdf

Beebe, K. R., R, J. P. & Seasholtz, M. B. (1998). *Chemometrics: A practical guide.* New York: John Wiley.

Bere, A. (2014). Exploring determinants for mobile learning user acceptance and use: An Application of UTAUT. *11th International Conference on Information Technology: New Generations.* Las Vegas, USA., 122-132

Berg, S. V. D. (2008). How effective are poor schools? Poverty and educational outcomes in South Africa. *Studies in Educational Evaluation*, *34*, 145–154.

Bezuidenhout, M. (2013). An investigation into the effect of mobile Poetry-based instruction on the literacy levels of grade 8 English first additional language learners within the South African rural context: a case study. MPhil in Hypermedia for Language Learning, Stellenbosch University.

Bingimlas, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. *EURASIA Journal of Mathematics*, *Science and Technology Education*, *5(3)*, 235–245.

Binyamin, S. S., Rutter, M. J. & Smith, S. (2019). Extending the technology acceptance model to understand students' use of learning management systems in Saudi higher education. *International Journal of Emerging Technologies in Learning (iJET)*, *13(3), 356-371*.

Birmingham, D. & Wilkinson, P. (2003). *Using research instruments: A guide for researchers*, New York: Routledge Falmer.

Bisman, J. (2010). Postpositivism and Accounting Research : A (Personal) Primer on Critical Realism. *Australasian Accounting*, *Business and Finance Journal*, 4(4), 212-233.

Blau, I. & Hameiri, M. (2017). Ubiquitous mobile educational data management by teachers, students and parents : Does technology change school-family communication and parental involvement? *Education and Information Technologies*, *22(3)*, 1231-1247.

Bosman, A. & Schulze, S. (2018). Learning style preferences and mathematics achievement of secondary school learners. *South African Journal of Education*, *38(1), 231-240*.

Bourgonjon, J., Valcke, M., Soetaert, R. & T. Schellens (2010). Students' perceptions about the use of educational games in the classroom. *Computers & Education*, *54(4)*, 1145-1156.

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*, Thousand Oaks: Sage.

Brandt, E., Hillgren, P. A. & Bjorgvinsson, E. B. (2009). Self-produced video to augment peer-to-peer learning. *Learning with Mobile Devices*, 2009, 27-34.

Bransford, J., Brown, A. & Cocking, R. (1999). *How people learn.*, Washington, DC: National Academy.

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3(2)*, 77-101.

Breckler, J., Teoh, C. & Role, K. (2011). Academic performance and learning style self-predictions by second language students in an introductory biology course. *Journal of the Scholarship of Teaching and Learning*, *11(4)*, 26-43.

Brierley, J. A. (2017). The role of a pragmatist paradigm when adopting mixed methods in behavioural accounting research. *International Journal of Behavioural Accounting and Finance*, *6(2)*, 140-154.

Buabeng-Andoh, C. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 8(1), 136-155.

Buedding, H. & Schroer, F. (2009). Knowledge to Go: Using mobile technologies for mobile learning inside and outside university and school. *International Journal of Mobile Learning and Organisation*, *3(1)*, 1-14.

Burke, L., Francis, K. & Shanahan, M. (2014). A horizon of possibilities: A definition of STEM education. S*TEM 2014 Conference*, 2014, Vancouver.

Burkholder, C., Makramalla, M., Abdou, E., Khoja, N. & Khan, F. (2015). Why study power in digital spaces anyway? Considering power and participatory visual methods. *Perspectives in Education*, *33(4)*, 6-22.

Caldwell, J. (2007). Clickers in the large classroom: Current research and best-practice tips. *Cell Biology Education*, *6(1)*, 9-20.

Callum, K. M. (2010). Attitudes of educators to the introduction of mobile technology. *1st annual conference of Computing and Information Technology Research and Education New Zealand (CITRENZ2010)*. Dunedin, New Zealand.

Callum, K. M. & Jeffrey, L. (2013). The influence of students' ICT skills and their adoption of mobile learning. *Australasian Journal of Educational Technology*, *29(3)*, 303-314.

Callum, K. M., Jeffrey, L. & Kinshuk, C. (2014). Factors impacting teachers' adoption of mobile learning. *Journal of Information Technology Education Research*, *13(1), 334-345*.

Camilleri, A. C. & Camilleri, M. A. (2019). The students' perceived use, ease of use and enjoyment of educational games at home and at school. *13th Annual International Technology*, *Education and Development Conference. Valencia, Spain: International Academy of Technology, Education and Development (IATED).*

Carlsson, C., Carlsson, J., Hyvonen, K., Puhakainen, J. & Walden, P. (2006). Adoption of mobile devices/services|searching for answers with the utaut. In *Proceedings of the 39th Annual Hawaii International Conference on System Sciences*, 2006. Hawaii, USA.

Castro, M., Expósito-Casas, E., López-Martín, E., Lizasoain, L., Navarro-Asencio, E. & Gaviria, J. L. (2015). Parental involvement on student academic achievement: A meta-analysis. *Educational Research Review*, *14*, 33–46.

Chaka, J. G. & Govender, I. (2017). Students' perceptions and readiness towards mobile learning in colleges of education: a Nigerian Perspective. *South African Journal of Education*, *37(1), 12-24*.

Chan, Y. L. & Norlizah, C. H. (2017). Students' motivation towards science learning and students' science achievement. *International Journal of Academic Research in Progressive Education and Development*, *6(4)*, 174-189.

Chen, W., Teo, M. H. & Nguyen, D. (2019). Singapore parents' use of digital devices with young children: Motivations and uses. *The Asia-Pacific Education Researcher*, 1-12.

Cheng, E. W. L. (2019). Choosing between the theory of planned behavior (TPB) and the Technology Acceptance Model (TAM). *Educational Technology Research and Development*, *67(1)*, 21–37.

Cheon, J., Lee, S., Crooks, S. S. M. & Song, J. (2012). An investigation of mobile learning readiness in higher education based on the theory of planned behaviour. *Computers and Education*, *59(3)*, 1054-1064.

Cheung, W. S. & Hew, K. F. (2009). A review of research methodologies used in studies on mobile handheld devices in K-12 and higher education settings. *Australasian Journal of Educational Technology*, *25*, 153–183.

Chin, W. W. (1996). The measurement and meaning of IT usage: Reconciling recent discrepancies between self reported and com puter recorded usage. *In:* AUBERT, B. A. & CHIN, W. W., eds. Sci. Assoc. Canada-24th Conf. IS Division Proc, 1996.

Chin, W. W.(1998). *The Partial Least Squares approach for structural equation modelling*, Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Chin, W. W. & Newsted, P. R. (1999). *"Structural equation modeling analysis with small samples using partial least squares"in Statistical strategies for small sample research*, Thousand Oaks: Sage.

Chiu, T. K. F. & Churchill, D. (2016). Adoption of mobile devices in teaching: changes in teacher beliefs, attitudes and anxiety. *Interactive Learning Environments*, *24(1), 317–327*.

Christensen, R. & Knezek, G. (2016) Relationship of mobile learning readiness to teacher proficiency in classroom. *Technology integration 13th International Conference on Cognition and Exploratory Learning in Digital Age (CELDA 2016).*

Christensen, R. & Knezek, G. (2017). Contrasts in openness toward mobile learning in the classroom: a study of elementary, middle and high school teachers. *14th International Conference on Cognition and Exploratory Learning in Digital Age (CELDA 2017).*

Chung, H.-H., Chen, S.-C. & Kuo, M.-H. (2015). A study of EFL college students' acceptance of mobile learning *Procedia- Social and Behavioral Sciences*, *176*, 333-339.

Clark, A. L. & Watson, D. (1995). Constructing validity: Basic issues in objective scale development. *Psychological Assessment*, *7(3)*, 309–319.

Cohen, J., Cohen, P., West, S. G. & Aiken, L. S. (2003). *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*, Mahwah, NJ: Lawrence Earlbaum Associates.

Cohen, L., Manion, L. & Morrison, K. (2007). *Research Methods in Education*, London: RoutledgeFalmer.

Collis, J. & Hussey, R. (2003). *Business research: a practical guide for undergraduate and postgraduate students* Basingstoke: Palgrave Macmillan.

Compeau, D. R. & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, *19(2)*, 189-211.

Compeau, D. R., Higgins, C. A. & Huff, S. (1999). Social cognitive theory and individual reactions to computing technology: A longitudinal study. *MIS Quarterly*, *23*, 145-158.

Cooper, D. R. & Schindler, P. S. (2008). *Business Research Methods*. New York, NY: McGraw-Hill.

Cowan, B. R. & Jack, M. A. (2011). Exploring the wiki user experience: The effects of training spaces on novice user usability and anxiety towards wiki editing. *Interacting with Computers*, *23(2)*, 117-128.

Creswell, J. W. (2003). *Research design. Qualitative*, *quantitative and mixed methods approaches*, Thousand Oaks, CA: Sage.

Creswell, J. W. (2013). *Research Design: Qualitative*, *Quantitative*, *and Mixed Methods* Los Angeles: Sage.

Creswell, J. W. (2015). *A Concise Introduction to Mixed Methods*, Los Angeles: Sage Publications.

Criollo-C, S., Luján-Mora, S. & Jaramillo-Alcázar, S. (2018). Advantages and disadvantages of M-learning in current education. *2018 IEEE World Engineering Education Conference (EDUNINE).*

Cutshall, R., Changchit, C. & Elwood, S. (2006). Campus Laptops: What logistical and technological factors are perceived critical? *Educational Technology and Society*, *9(3)*, 112-121.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13(3)*, 319-340.

Davis, F. D. (1993). User acceptance of information technology: System characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies*, *38(3)*, 475-487.

Davis, F. D., Bagozzi, R. P. & Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology*, *22(4)*, 1111-1132.

de Jager, T. (2012). Using visual media to enhance science teaching and learning in historically disadvantaged secondary schools. *International Proceedings of Economics Development and Research*, *47*, 1.

Demirci, A. (2009). How do teachers approach new technologies: geography teachers' attitudes towards Geographic Information Systems (GIS). *European Journal of Educational Studies*, *1*.

Devlin, K. (1997). *Why we should reduce skills teaching in the Math class*, Washington, DC: The Mathematical Association of America.

Dillenbourg, P. (1999). What do you mean by collaborative learning? *Collaborative learning: Cognitive and computational approaches,* 1-19.

Dilshad, R. M. & Latif, M. I. (2013). Focus group interview as a tool for qualitative research: An analysis. *Pakistan Journal of Social Sciences (PJSS)*, *33(1)*, 191-198.

Doll, W. J., Hendrickson, A. & Deng, X. (1998). Using Davis's perceived usefulness and ease-of-use instruments for decision making: A confirmatory and multi-group invariance analysis. *Decision Sciences*, *29(4)*, 839-869.

Donaldson, R. L. (2011). Student Acceptance of Mobile Learning. Doctor of Philosophy, Florida State University, USA.

Duncan, D. (2006). Clickers: A new teaching aid with exceptional promise. *Astronomy Education Review*, *5(1)*, 70-88.

Dündar, H. & Akçayır, M. (2014). Implementing tablet PCs in schools: Students' attitudes and opinions. *Computers in Human Behavior*, *32*, 40-46.

Dutota, V., Bhatiasevib, V. & Bellallahom, N.(2019). Applying the technology acceptance model in a three-countries study of smartwatch adoption. *Journal of High Technology Management Research*, *30*, 1–14.

Eagly, A. H. & Chaiken, S. (1993). *Psychology of attitudes*, Orlando, FL: Harcourt Brace Jovanovich College Publishers.

Easterby-Smith, M., Thorpe, R., Jackson, P. & Lowe, A. (2008). *Management Research*, London: Sage.

Economides, A. & Grousopoulou, A. (2008). Use of mobile phones by male and female Greek students. *International Journal of Mobile Communications (IJMC)*, *6(6)*, 729-749.

DoE (2011a). *Curriculum and Assessment Policy Statement Grade 10 - 12 Physical Sciences*. Pretoria: Government Printing Works.

DoE (2011b). *Natural sciences: Curriculum and assessment policy statement*. Pretoria: Government Printing Works.

DoE (2014). *National Senior Certificate Examination Report on Learners Perfomance*.. Pretoria: Government Printing Works.

DoE (2015). *National Senior Certificate Diagnostic Report on Learner-Performance*. Pretoria: Government Printing Works.

DoE (2016). *National Senior Certificate Diagnostic Report on Learner-Performance*. Pretoria: Government Printing Works.

DoE (2017). *National Senior Certificate Diagnostic Report on Learner-Performance*. *Part 1.* Pretoria: Government Printing Works.

DoE (2018). *National Senior Certificate Diagnostic Report on Learner-Performance*. Pretoria: Government Printing Works.

El-Deghaidy, H. & Mansour, N. (2015). Science teachers' perceptions of STEM education: Possibilities and challenges. *International Journal of Learning and Teaching*, *1(1)*, 51-54.

El-Gayar, O. & Moran, M. (2007). Examining students' acceptance of tablet PC's using TAM. *Issues in Information Systems*, *8(1)*, 167–172.

English, L. D. (2015). STEM: Challenges and opportunities for mathematics education. In K.,Beswick, T. Muir, , & J. Wells (Eds.). *Proceedings of the 39th Conference of the International Group for the Psychology of Mathematics Education*.Hobart, Tas. PME, 4-18.

Erlich, Z., Erlich-Philip, I. & Gal-Ezer, J. (2005). Skills required for participating in CMC courses: An empirical study. *Computers & Education*, *44(4)*, 477-487.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, *53*, 25–39.

F Ferreira, Dias, F., Braz, J., Santos, R., Nascimento, R., Ferreira, C. & Martinho, R. (2013). Protege: a mobile health application for the elder-caregiver monitoring paradigm. *Procedia Technology*,, *9*, 1361–1371.

Falk, R. F. & Miller, N. B. (1992). *A primer for soft modeling*. Akron, Ohio: University of Akron Press.

Fathema, N., Shannon, D. & Ross, M. (2015). Expanding the technology acceptance model (TAM) to examine faculty use of learning management systems (LMSs) in higher education institutions. *Journal of Online Learning & Teaching*, *11(2)*, 220-232.

Fathema, N. & Sutton, K. L. (2013). Factors influencing faculty members' learning management systems adoption behavior: An analysis using the technology acceptance model. *International Journal of Trends in Economics Management & Technology*, *2(6)*, 20-28.

Fidel, R. (2008). Are we there yet? Mixed methods research in library and information science. *Library and Information Science Research*, *30*, 265-272.

Fink, A. (2009). *How to conduct surveys*, Thousand Oaks, CA: Sage.

Fishbein, M. & Ajzen, J. (1975). *Beliefs*, *Attitudes*, *Intention*, *and Behavior: An Introduction of Theory and Research*. Reading, MA:, Addison Wesley Publishing.

Flick, U. (2002). *An Introduction to Qualitative Research*,. London, Sage.

Foddy, W. (1993). *Constructing questions for interviews and questionnaires: Theory and Practice in Social Research*. Cambridge: Cambridge University Press.

Ford, M. & Botha, A. (2010). A pragmatic framework for Integrating ICT into education in South Africa. In P. C. A. M. Cunningham (Ed.). *IST-Africa 2010 Conference Proceedings*, 2010.

Fornell, C. & Cha, J. (1994). *Partial least squares. Advanced Methods of Marketing Research*, *407*, 52-78.

Forum, W. E. (2015). The global competitiveness report 2015–2016. Geneva: WEF.

Francis, J., Eccles, M., Johnston, M., Walker, A., Grimshaw, J. & Foy, R. (2004). *Constructing questionnaires based on the theory of planned behaviour: A manual for health services researchers.* Newcastle, University of Newcastle.

Fu, J. R. (2006). *VisualPLS–Partial Least Square (PLS) Regression–An Enhanced GUI for LVPLS (PLS 1.8 PC) Version 1.04*. Taiwan, National Kaohsiung University of Applied Sciences.

Fuchs, C. & Horak, E. (2006). Africa and the digital divide. *Telematics and Informatics*, *25*, 99-116.

Garson, G. D. (2016). *Partial Least Squares: Regression & Structural Equation Models.*, Asheboro, NC: Statistical Publishing Associates.

Gedik, N., Hanci-Karademirci, A., Kursun, E. & Cagiltay, K. (2012). Key instructional design issues in a cellular phone-based mobile learning project. *Computers & Education*, *58(4)*, 1149–1159.

Gefen, D., Straub, D. W. & Boudreau, M. C. (2000). Structural equation modelling and regression: Guidelines for research practice. *Communication of the Association for Information Systems*, *4(7)*, 2-77.

Genc, Z. (2014). Parents' perceptions about the mobile technology use of preschool aged children. *Social and Behavioral Sciences*, *146(2014)*, 55-60.

Gold, A. H., Malhotra, A. & Segars, A. H. (2001). Knowledge management: An organizational capabilities perspective. *Journal of Management Information Systems*, *18(1)*, 185–214.

Goodall, J. S. (2016). Technology and school-home communication. *International Journal of Pedagogies and Learning*, *12(11)*, 118-131.

Gotz, O., Liehr-Gobbers, K. & Krafft, M. (2010). *Evaluation of structural equation models using the partial least squares (PLS) approach*., Heidelberg: Springer handbooks.

Grimus, M. & Ebner, M. (2014). Learning and teaching with mobile devices an approach in secondary education in Ghana. *10th International Conference Mobile Learning*, 2014.

Gu, X., Zhu, Y. & Guo, X. (2013). Meeting the “Digital Natives”: Understanding the Acceptance of Technology in classrooms. *Educational Technology & Society*, *16*, 392–402.

Hair, J. F., Black, W. C., Babin, B. J. & Anderson, R. E. (2014). *Multivariate Data Analysis.*, Harlow: Pearson.

Hair, J. F., Ringle, C. M. & Sarstedt, M. (2011). PLS-SEM: Indeed a Silver Bullet. *The Journal of Marketing Theory and Practice*, 19(2), 139-152.

Hair, J. F., Sarstedt, M., Pieper, T. M. & Ringle, C. M. (2012). The use of partial least squares structural equation modeling in strategic management research: A review of past practices and recommendations for future applications. *Long Range Planning*, *45*, 320-340.

Hair, J. F. J., Black, W. C., Babin, B. J., Anderson, R. E. & Tatham, R. (2006). *Multivariate Data Analysis.*, Upper Saddle River: Pearson Prentice Hall.

Hair, J. J. F., Black, W. C., Babin, B. J. & Anderson, R. E. (2010). *Multivariate Data Analysis: A Global Perspective.*, London: Pearson.

Hair, J. J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). *A primer on partial least squares structural equation modeling (PLS-SEM)*, London: SAGE Publications, Inc.

Hair, J. J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (PLS-SEM)*, London: SAGE Publications

Hamzah, A. & Muchlis, N. F. (2018) The exploration through the factors affecting students' adoption on M-learning technologies. *AIP Conference Proceedings 1977*, *2018*. American Institute of Physics.

Hanif, M. & Asrowi, A. (2018). Mobile learning perception of graduate student teachers: a case study in magister program of educational technology of University of Sebelas Maret. *International Journal of Multicultural and Multireligious Understanding*, *5(1)*, 84-91.

Hao, S., Dennen, V. P., & Mei, L. (2017). Influential factors for mobile learning acceptance among Chinese users. *Educational Technology Research and Development*, *65(1)*, 101-123.

Henderson, R. & Divett, M. J. (2003). Perceived usefulness, ease of use and electronic supermarket use. *International Journal of Human-Computer Studies*, *59*, 383-395.

Henseler, J., Christian, M. R., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in internation marketing. *New Challenges to International Marketing Advances in International Marketing*, *20*, 277-319.

Henseler, J., Hubona, G., & Ray, P. A. (2016). Using PLS path modeling in new technology research: updated guidelines. *Industrial management & data systems*, *116(1)*, 2-20.

Henseler, J., Ringle, C. M. & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43(1)*, 115-135.

Hermans, R., Tondeur, J., Braak, J. V. & Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers & Education*, *51(4)*, 1499-1509.

Hew, K. & Brush, T. 2007. Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research & Development*, *55(3)*, 223–252.

Hiniker, A., Schoenebeck, S. Y., & Kientz, J. A. (2016). Not at the dinner table: Parents' and children's perspectives on family technology rules. *19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*, 2016. New York, NY: ACM, 1376-1389.

Hixon, E. & Buckemeyer, J. (2009). Revisiting technology integration in schools: Implications for professional development. *Computers in the Schools*, 26,130–146.

Hoban, G. (2009) Using mobile phone cameras to capture images for slowmantions: Student-generated science animations. In J. Herrington, A. Herrington, J. Mantei, & I. Olney (Eds.), *New technologies*, *new pedagogies: Mobile learning in higher education*, 2009. Wollongong: University of Wollongong.

Hu, P. J., Clark, T. H. K,. & Ma, W. W. (2003). Examining technology acceptance by school teachers: A longitudinal study. *Information & Management*, *41*, 227-241.

Huang, J.-H., Lin, Y.-R., & Chuang, S.-T. (2006). Elucidating user behavior of mobile learning: A perspective of the extended technology acceptance model. *The Electronic Library*, *252(5)*, 585-598.

Huang, Y. (2014). Empirical analysis on factors impacting mobile learning acceptance in higher engineering education. Doctor of Philosophy, University of Tennessee.

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: a review of four recent studies. *Strategy Management Journal Research*, *20(4)*, 195-204.

Hussin, S., Manap, M. R., Amir, Z. & Krish, P. (2012). Mobile learning readiness among Malaysian students at higher learning institutes. *Asian Social Science*, *8(12)*, 276-283.

Hwang, G. J. & Chang, H. F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. *Computers & Education*, *56(4)*, 1023-1031.

Iqbal, S. & Bhatti, Z. A. (2015). An investigation of university student readiness towards M-learning using Technology Acceptance Model. *International Review of Research in Open and Distributed Learning*, *16(4)*, 83-103.

Iqbal, S. & Bhatti, Z. A. (2017). What drives M-learning? An emprical investigation of university student perceptions in Pakistan. *Higher Education Research & Development*, *36(1)*, 730-746.

Ismail, I., Azizan, S. N. & Gunasegaran, T. (2016). Mobile learning in Malaysian universities: Are students ready? *International Journal of Interactive Mobile Technologies (iJIM)*, *10(3)*, 17-23.

Ismail, I., Idrus, R. M. & Johari, S. S. M. (2010). Acceptance on mobile learning via SMS: a Rasch model analysis. *International Journal of Interactive Mobile Technologies (iJIM)*, *4(2)*, 10-16.

Jairak, K., Praneetpolgrang, P. & Mekhabunchakij, K. (2009). An acceptance of mobile learning for higher education students in Thailand. *Special Issue of the International Journal of the Computer*, *the Internet and Management*, *17(3)*, 36, 1–368.

Jantjies, M. & Joy, M. (2015). Mobile enhanced learning in a South African context. *Journal of Educational Technology & Society*, *18(1)*, 308-350.

Jaradat, M. (2010). Understanding the acceptance of mobile university services: an empirical analysis. *International Journal of Mobile Learning and Organisation*, 4(4), 407-427.

Jeffrey, L., Hegarty, B., Kelly, O., Penman, M., Coburn, D., & Mcdonald, J. (2011). Developing digital information literacy in higher education: Obstacles and supports *Journal of Information Technology Education*, 10(1), 383-413.

Jeynes, W. (2003). A meta analysis: The effects of parental involvement on minority children's academic achievement. *Education and Urban Society*, *35(1)*, 202-223.

Jones, J. L., & Sinclair, B. (2011). Assessment on the go: Surveying students with an iPad. Journal of Library Innovation, 2(2), 22-35.

Joo, Y. J., Park, S. & Lim, E. (2018). Factors influencing preservice teachers' intention to use technology: TPACK, Teacher Self-efficacy, and Technology Acceptance Model. *International Forum of Educational Technology & Society*, *21()*, 48-59.

Joyce-Gibbons, A., Galloway, D., Mollel, A., Mgoma, S., Pima, M. & Deogratias, E. (2018). Mobile phone use in two secondary schools in Tanzania. *Educational Information Technology*, *23*, 73-92.

Juškevičienė, A. & Kurilovas, E. (2014). On recommending Web 2.0 tools to personalise learning. *Informatics in Education*, *13(1)*, 17–31.

Kadir, D. & Ercan, A. 2018. The effect of mobile learning applications on students' academic achievement and attitudes toward mobile learning. *Malaysian Online Journal of Educational Technology*, *6(2), 233-245*.

Kagan, D. M. (1992). Implication of research on teacher belief. *Educational Psychologist*, *27*, 65-90.

Kale, U. (2015). An exploration of pre-service teachers' intention to use mobile devices for teaching. *International Journal of Mobile and Blended Learning*, *7(3)*, 1-18.

Kee, C. & Samsudin, Z. (2014). Mobile devices: toy or learning tools for the 21st century teenagers. *The Turkish Online Journal of Educational Technology*, *13(3)*, 85-100.

Keegan, D. (2005). The incorporation of mobile learning into mainstream education and training. In H.V.D. Merwe, & T. Brown, (Eds), *4th World Conference on Mobile Learning. Mobile technology: The future of learning in your hands* (pp. 1-17). Cape Town, South Africa.

Khan, A. I., Al-Shihi, H., Al-Khanjari, Z. A. & Sarrab, M. (2015). Mobile learning (M-learning) adoption in Middle East: Lessons learned from educationally advanced countries. *Telematics and Informatics*, *32(4), 345-356*.

Khryashchev, V., Kasatkina, N., & Sokolenko, D. (2017). Readiness for Mobile Learning: Multidisciplinary Cases From Yaroslavl State University. *13th International Conference Mobile Learning*, Budapest, Hungary.

Kiger, D. & Herro, D. (2015). Bring your device: Parental guidance (PG) suggested. *TechTrends*, *59(5)*, 51-61.

Kihwele, J. E. & Bali, T. A. L. (2013). The perceptions of teachers, parents and students on the effects of mobile phone use on student learning in Tanzania. *Journal of Education and Practice*, 25(*4)*.

Kim, C., Kim, M. K., Lee, C., J. M Spector & Demeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, *29*, 76-85.

Kim, J. (2013). Measuring factors that influence teachers' willingness in using mobile phone in the classroom. In M. M. Searson, (Ed.) *Proceedings of Society for Information Technology & Teacher Education International Conference 2013.* Chesapeake, VA: AACE.

Kline, R. B. (2011). *Principles and practice of structural equation modeling*, New York: Guilford Press.

Koehler, M. J. & Mishra, P. (2016). *Introducing to TPACK: Handbook of Technological Pedagogical Content Knowledge (TPACK) for Educators*, New York: Routledge.

Kong, S. C. (2018). Parents' perceptions of e-learning in school education: Implications for the partnership between schools and parents. *Technology Pedagogy and Education*, 27(1), 15–31.

Kong, S. C. & Li, K. M. (2009). Collaboration between school and parents on fostering information literacy: Learning in the information society. *Computers and Education*, 52(2), 275–282.

Korte, W. B. & Husing, T. (2007). Benchmarking access and use of ICT in European schools 2006: Results from head teacher and a classroom surveys in 27 European countries. *Elearning papers*, 29(10), 1-6.

Kreutzer, T. (2009). Generation mobile: Online and digital media usage on mobile phones among low-income urban youth in south africa. *Journal for Research in Mathematics Education*.

Ku, C.-H. (2009). Extending the technology acceptance model using perceived user resources in higher education web-based online learning courses. Doctor of Philosophy, University of Central Florida.

Kukulska-Hulme, A. & Traxler, J. (2007). Learning design with mobile and wireless technologies. *In:* Beetham, H. & Sharpe, R., eds. Rethinking Pedagogy for the Digital Age, 2007 London: Routledge.

Kumar, B. A. & Chand, S. S. (2019). Mobile learning adoption: A systematic review. *Education and Information Technologies*, 24(1), 471–487

Kumar, N., Rose, R. C. & D'silva, J. L. (2008). Teachers' readiness to use technology in the classroom: An empirical study. *European Journal of Scientific Research*, 21(4), 603-616.

Lacobucci, D. (2010). Structural equations modeling: Fit Indices, sample size, and advanced topics. *Journal of Consumer Psychology*, 20, 90-98.

Lam, P., Wong, K., Cheng, R., Ho, E. & Yuen, S. (2011). Changes in students' mobile learning readiness- comparison of survey data collected over a nine-month period. *In Proceedings of the Global Learn Asia Pacific (Global learn 2011)* Melbourne, Australia.

Lan, Y. F. & Tsai, P. W. (2011). Using mobile-memo to support knowledge acquisition and posting-questions in a mobile learning environment. *US-China Education Review*, 5, 632-638.

Leem, J. & Sung, E. (2018). Teachers' beliefs and technology acceptance concerning smart mobile devices for SMART education in South Korea. *British Journal of Educational Technology*, 00.

Lefoe, G., Olney, I. W., Wright, R. & Herrington, A. (2009). Faculty development for new technologies: Putting mobile learning in the hands of the teachers. In J. Herrington , A. Herrington, J. Mantei, I. Ol-Ney, & B. Ferry (Eds.). *New technologies*, *new pedagogies: Mobile learning in higher education.* Wol-longong, Australia: University of Wollongong.

Léger, M. T. & Freiman, V. (2016). A narrative approach to understanding the development and retention of digital skills over time in former middle school students, a decade after having used one-to-one laptop computers. *Journal of Research on Technology in Education*, 48(1), 57-66.

Leung, C. & Chan, Y. (2003, July 9-11). mLearning: A new paradigm in electronic learning. *3rd IEEE ICALT*, Athens, (pp. 76-84).

Levin, T. & Wadmany, R. (2008). Teachers' views on factors affecting effective integration of information technology in the classroom: Developmental scenery. *Journal of Technology and Teacher Education*, 16(2), 233–263.

Lewin, C. & Luckin, R. (2010). Technology to support parental engagement in elementary education: Lessons learned from the UK. *Computers and Education*, 54(3), 749–758.

Li, R., Meng, Z., Tian, M., Zhang, Z., Ni, C. & Xiao, W. (2019). Examining EFL learners' individual antecedents on the adoption of automated writing evaluation in China. *Computer Assisted Language Learning*.

Li, Y. (2005). PLS-GUI–Graphic user interface for partial least squares (PLS-PC 1.8)–Version 2.0. 1 beta. *Columbia*, *SC*: *University of South Carolina*,

Li, Y., Zhang, Y., Lu, F., Zhang, Q. & Wang, Y. (2013). Internet addiction among elementary and middle school students in Chine: A national representative sample study. *Cyberpsychology, behaviour, and social networking,*, 17(2), 111-116.

Liu, S.-H. (2016). The perceptions of participation in a mobile collaborative learning among pre-service teachers. *Journal of Education and Learning*, 5(1), 87-94.

Liu, S. H., Liao, H. L. & Pratt, J. A. (2009). Impact of media richness and flow on e-learning technology acceptance. *Computers & Education*, 52(3), 599–607.

Liu, Y. & Han, S. (2010). Understanding the factors driving M-learning adoption: A literature review. *Campus-Wide Information Systems*, 27(2), 210-226.

Liu, Y. & Li, H. (2011). Exploring the impact of use context on mobile hedonic services adoption: An empirical study on mobile gaming in china. *Computers in Human Behavior*, 27(2), 890-898.

Liu, Y., Li, H. & Carlsson, C. (2010). Factors driving the adoption of M-learning: An empirical study. *Computers & Education*, 55(3), 1211–1219.

Liu, Y., Rao, J., Liu, P. & Zhou, P. (2018). An empirical study on factors influencing stendents' intention on M-learning in middle school of china. *2018 IEEE 18th International Conference on Advanced Learning Technologies.*

Lohmoller, J. B. (1988). The PLS program system: Latent variables path analysis with partial least squares estimation *Multivariate Behavioral Research*, 23, 125-127.

Lopez, D. A. & Manson, D. P. (1997). A study of individual computer self-efficacy and perceived usefulness of the empowered desktop information system. *Journal of Interdisciplinary Studies*, 10

Lowenthal, J. (2010). Using mobile learning: determinates impacting behavioral intention. *American Journal of Distance Education*, 24(4), 195-206.

Lu, J., Yu, C. S., Liu, C. & Yao, J. (2003). Technology acceptance model for wireless internet. internet research: Electronic networking applications and policy. *internet research: Electronic Networking Applications and Policy*, 13(3), 206-222.

Lu, X. & Viehland, D.(2008) Factors influencing the adoption of mobile learning. *19th Australasian Conference on Information Systems, 2008 Christchurch, New Zealand.*

Lueder, D. C. (1998). *Creating Partnerships with Parents: An educator's guide*, Lancaster, PA: Technomic Pub.

Lunetta, V. N. (1988). Laboratory/practical activities in Science education. Goal, strategies and teacher education: Learning difficulties and teaching strategies in secondary school science and mathematics. *Proceedings Regional Conference*. Botswana. Amsterdam: Free University Press.

Mahat, J., Ayub, A. F. & Luan, S. (2012). An assessment of students' mobile self-efficacy, readiness and personal innovativeness towards mobile learning in higher education in Malaysia. *Procedia-Social and Behavioral Sciences*, 65, 284-290.

Makgato, M. (2007). Factors associated with poor performance of learners in mathematics and physical science in secondary schools in Soshanguve, South Africa. *Africa Education Review*, 4(1), 89-103.

Maldonado, H. & Pea, R. D. (2010). Co-design of water quality inquiry using mobile science collaboratories. *Proceedings of 6th IEEE International Conference on Wireless, Mobile and Ubiquitous Technologies in Education*, Kaohsiung, Taiwan (pp.81-87).

Males, S., Bate, F. & Macnish, J. (2017). The impact of mobile learning on student performance as gauged by standardised test (NAPLAN) scores. *Issues in Educational Research*, 27(1), 99-114.

Mallat, N., Matti, R., Tuunainen, V. & Oorni, A. (2008). An empirical investigation of mobile ticketing service adoption in public transportation. *Personal and Ubiquitous Computing*, 12(1), 57-65.

Maravanyika, O. E. (1986). Towards a curriculum analysis model for national development. *Zambezia: The Education Supplement*, 1-27.

Marty, P., Douglas, I., Southerland, S., Sampson, V., Alemanne, N., Clark, A., A Mendenhall, Paz, A. D. L., & Yu, C. (2012). Habitat tracker: Learning about scientic inquiry through digital journaling in wildlife centers. In *Proceedings of iConference*, Toronto, Canada (pp. 560-562).

Mashaba, E. K. & Maile, S. (2018). Factors underlying teacher absenteeism in selected schools located in Tshwane West District, South Africa. *International Journal of Education and Development in Africa*, 4(1), 1-24.

Mathieosn, K. (1991). Predicting user intentions: Comparing the technology acceptance model with the theory of planned behavior. *Information System Research*, 2(3), 173-191.

Mathieson, K., Peacock, E. & Chin, W. W. (2001). Extending the Technology Acceptance Model: the influence of perceived user resources. *ACM SIGMIS Database*, 32(3), 86-112.

Mboweni, L. (2014). Challenges and factors contributing to learner absenteeism in selected primary schools in Acornhoek. Master of Education, University of South Africa.

Mills, M. (2012). PBS. National PBS Survey Finds Teachers Want More Access to Classroom Tech. http://www.pbs.org/about/news/archive/2012/teacher-survey-fetc/

Mji, A. & Makgato, M. (2006). Factors associated with high school learners' poor performance: a Spotlight on Mathematics and Physical Science. *South African Journal of Education*, 22(2), 57-63.

Modisaotsile, B. M. (2012). The failing standard of basic education in south africa. *AISA POLICYbrief.* Africa Institute of South Africa.

Mohammadi, F. & Mahmoodi, F. (2019). Factors affecting acceptance and use of educational wikis: Using Technology Acceptance Model (3). *Interdisciplinary Journal of Virtual Learning in Medical Sciences*, 10(1), 45-61.

Mokgwathi, M. S., Graham, M. A. & Fraser, W. (2019). The relationship between grade 9 teacher's and learner's perceptions and attitudes with their mathematics achievement. *International Journal of Instruction*, 12(1), 841-850.

Momani, F. & Abualkishik, A. (2014). Factors influencing students' intention to adopt a mobile blackboard. *International Journal of Science and Research*, 3(5), 2012-2015.

Monsuwe, T. P., Dellaert, B. G. C. & Ruyter, K. D. (2004). What drives consumers to shop online? A literature review. *International Journal of Service Industry Management*, 15(1), 102-121.

Montrieux, H., Grove, F. D. & Schellens, T. (2014). Mobile learning in secondary education: Teachers' and students' perceptions and acceptance of tablet computers. *International Journal of Mobile and Blended Learning*, 6(2), 26-40.

Moon, J. & Kim, Y. (2001). Extending the tam for a world-wide-web context. *Information & Management*, 38(4), 217-230.

Morris, M. G. & Venkatesh, V. (2000). Age differences in technology adoption decisions: Implications for a changing workforce. *Personnel Psych*, 53, 375-403.

Mtebe, J. S. & Raisamo, R. (2014). Investigating students' behavioural intention to adopt and use mobile learning in higher education in East Africa. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 10(3), 4-20.

Mtega, W. P., Bernard, R., Msungu, A. C., & Sanare, R. (2012). Using mobile phones for teaching and learning purposes in higher learning institutions: The case of Sokoine University of Agriculture in Tanzania. In *5th Ubuntu Net Alliance annual conference.*

Mueller, J., Wood, E., Willoughby, T., Ross, C., & Specht, J. (2008). Identifying discriminating variables between teachers who fully integrate computers and teachers with limited integration. *Computers & Education*, 51(4), 1523-1537.

Muhammet, B. & Okan, S. (2018). Determining the readiness levels of pre-service teachers towards mobile learning in classroom management. *Academic Journals*, 13.

Mumba, P. & Lengwe, M. (2018). Assessing the readiness of students to use mobile applications in collaborative learning: A Case of Copperbelt University. *Zambia Information Communication Technology (ITC) Journal*, 2(2), 1-7.

Mupira, P. & Ramnarain, U. (2017). The effect of inquiry-based learning on the achievement goal-orientation of grade 10 physical sciences learners at township schools in South Africa. *Journal of Research in Science Teaching*, 55, 810-825.

Mupira, P. & Ramnarain, U. (2018). The effect of inquiry-based learning on the achievement goal-orientation of grade 10 physical sciences learners at township schools in South Africa. *J Res Sci Teach*, 55, 810-825.

Musa, M. & Othman, S. (2012). Critical success factor in e-learning: an examination of technology and student factors. *International Journal of Advances in Engineering & Technology*, 3(2), 140-148.

Mutono, A. & Dagada, R. (2016). An investigation of mobile learning readiness for post-school education and training in south africa using the technology acceptance model. *International Journal of Education and Research*, 4(9), 353-366.

Naik, B. (2013). Influence of culture on learning styles of business students. *International Journal of Education Research*, 8(1), 129-139.

Nassuora, A. B. (2013). Students acceptance of mobile learning for higher education in Saudi Arabia. *International Journal of Learning Management Systems*, 1(1), 1-9.

Nel, N. & Nel, M. (2016). *Learner support in a diverse classroom: A guide for foundation*, *intermediate and senior phase teachers of Language and Mathematics*. Pretoria: Van Schaik.

Nikken, P. & Haan, J. D. (2015). Guiding young children’s internet use at home: Problems that parents experience in their parental mediation and the need for parenting support. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, 9.

Nikou, S. A. & Economides, A. A. (2016). An outdoor mobile-based assessment activity: measuring students’ motivation and acceptance. *International Journal of Interactive Mobile Technologies (iJIM)*, 10(4), 11-17.

Nikou, S. A. & Economides, A. A. (2018). Mobile-based micro-learning and Assessment: Impact on learning performance and motivation of high school students. *Journal of Computer Assisted learning*, 28, 269-278.

Nistor, N., Baltes, B., Dascălu, M., Mihăilă, D., Smeaton, G., & Trăuşan-Matu, Ş. (2014). Participation in virtual academic communities of practice under the influence of technology acceptance and community factors. A learning analytics application. *Computers in Human Behavior*, 34, 339–344.

Nkambule, G. & Amsterdam, C. (2018). The realities of educator support in a South African school district. *South African Journal of Education*, 38(1), 351-362.

Nokwali, M. P., Mammen, K. J., & Maphosa, C. (2015). How is technology education implemented in South African schools? Views from technology education learners. *International journal of Science Education*, 8(3), 563-571.

Nunally, J. C. & Bernstein, I. (1994). *Psychometric theory*, New York: McGraw-Hill.

Nunnally, J. (1978). *Psychometric theory*, New York: McGraw-Hill.

Oates, B. (2006). *Researching Information Systems And Computing* London, Sage.

Oblinger, D. & Oblinger, J. (2005). *Educating the Net generation*. In D.Oblinger, & J.Oblinger, (Eds.). Washington: Educause.

Odiakaosa, O. J., Dlodlo, N. & Jere, N. (2017). Teacher and learner perceptions on mobile learning technology: A case of Namibian high schools from the Hardap region. *Higher Educator-An International Journal*, 1(1), 13-41.

Ong, C. S. & Lai, J. Y. (2006). Gender differences in perceptions and relationships among dominants of e-learning acceptance. *Computers in Human Behavior*, 22(5), 816-829.

Onwuegbuzie, A. J. (2003). Effect sizes in qualitative research: A prolegomenon. Quality & Quantity. *International Journal of Methodology*, 37, 393–409.

Onwuegbuzie, A. J. & Leech, N. L. (2005). On becoming a pragmatic researcher: the importance of combining quantitative and qualitative research methodologies. *International Journal of Social Research Methodology*, 8(5), 375-387.

Osakwe, J., Dlodlo, N. & Jere, N. (2017). Where learners' and teachers' perceptions on mobile learning meet: A case of Namibian secondary schools in the Khomas region. *Technology in Society*, 49(2007), 16-30.

Ottenbreit-Leftwich, A., Glazewski, K. D., Newby, T. J & Ertmer, P. A. (2010). Teacher value beliefs associated with using technology: Addressing professional and student needs. *Computers & Education*, 55(3), 1321-1335.

Özdamli, F. & Yildiz, E. P. (2014). Parents' views towards improve parent-school collaboration with mobile technologies. *Procedia–Social and Behavioral Sciences*, 131, 361-366.

Padilla-Meléndez, A., Aguila-Obra, A. R. D. & Garrido-Moreno, A. (2012). Perceived playfulness, gender differences and technology acceptance model in a blended learning scenario. *Computers & Education*, 63(2013), 306-317.

Padmanathan, Y. & Jogulu, L. N. (2018). Mobile learning readiness among Malaysian Polytechnic students. *Journal of Information System and Technology Management*, 3(8), 113-125.

Pallani, J. (2010). *SPSS survival manual: a step by step guide to data analysis using IBM SPSS*, Maidenhead: Open University Press/ McGraw-Hill.

Pan, C. C. (2003). System use of WebCT in the light of the technology acceptance model: a student perspective. Doctor of Philosophy, University of Central Florida.

Panda, S. & Mishra, S. (2007). E-learning in a mega open university: faculty attitude, barriers and motivators. *Educational Media International*, 44(4), 323-338.

Park, S. & Holloway, S. D. (2017). The effects of school-based parental involvement on academic achievement at the child and elementary school level: A longitudinal study. *The Journal of Educational Research*, 110(1), 1-16.

Park, S. Y.(2009). An analysis of the technology acceptance model in understanding university students' behavioral intention to use e-learning. *Educational Technology & Society*, 12(3), 150-162.

Park, S. Y., Nam, M.-W. & Cha, S.-B. (2012). University students' behavioral intention to use mobile learning: Evaluating the Technolog Acceptance Model. *British Journal of Educational Technology*, 43(4), 592- 605.

Park, Y. (2011). A pedagogical framework for mobile learning: Categorizing educational applications of mobile technologies into four types. *International Review of Research in Open and Distance Learning*, 12(2), 78-102.

Park, Y. & Chen, J. (2007). Acceptance and adoption of the innovative use of smartphone. *Industrial Management and Data Systems*, 107(9), 1349-1365.

Parsons, D. & Adhikari, J. (2016). Bring your own sevice to secondary school: The perceptions of teachers, students and parents. *The Electronic Journal of e-Learning*, 14(1), 66-80.

Patton, M. Q. (2002). *Qualitative research and evaluation methods*, Thousand Oaks: Sage.

Pedersen, P. E. & Ling, R. (2003). Modifying adoption research for mobile internet service adoption: Cross-disciplinary interactions. In *Proceedings of the 36th Annual Hawaii International Conference on System Sciences (HICSS'03)*. *IEEE Computer Society*, 5, 91-95.

Pedró, F. (2007). The new Millennium learners: challenging our views on digital technologies and learning. *Nordic Journal of Digital Literacy*, 2(4), 244–264.

Pei-Shan, T., Chin-Chung, T. & Gwo-Haur, H. (2010). Elementary school students' attitudes and self-efficacy of using pdas in a ubiquitous learning context. *Australasian Journal of Educational Technology*, 26(3), 297-308.

Persico, D., Manca, S. & Pozzi, F. (2014). Adapting the technology acceptance model to evaluate the innovative potential of e-learning systems. *Computers in Human Behavior*, 30, 614–622.

Pimmera, C., Brysiewicz, P., Linxen, S., Walters, F., Chipps, J., & Ursgröhbiel (2014). Informal mobile learning in nurse education and practice in remote areas. A case study from rural South Africa. *Nurse Education Today*, 34, 135-147.

Pinker, S. (1997). *How the Mind Works*, New York: W. W. Nortan.

Pinkwart, N., Hoppe, H. U., Milrad, M., & Perez, J. (2003). Educational scenarios for the cooperative use of personal digital assistants. *Journal of Computer Assisted Learning*, 19(3), 383-391.

Poong, Y., Yamaguchi, S. & Takada, J. (2016). Investigating the drivers of mobile learning acceptance among young adults in the world heritage town of Luang Prabang, Loas. *Information Development*, 33(1), 57-71.

Pournara, C., Hodgen, J., Adler, J., & Pillay, V. (2015). Can improving teachers' knowledge of mathematics lead to gains in learners' attainment in Mathematics? . *South African Journal of Education*, 35(3), 567-579.

Pramana, E. (2018). Determinants of the adoption of mobile learning systems among university students in Indonesia. *Journal of Information Technology Education: Research*, 17, 365-398.

Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon*, 9, 1–6.

Prinsloo, J. & Janks, H. (2002). Critical literacy in South Africa: Possibilities and constraints in 2002. *English Teaching: Practice and Critique*, 1(1), 20-38.

Project Tomorrow (2010). Learning in the 21st century: Taking it mobile! Project Tomorrow and Blackboard K-12.

Pynoo, B., Devolder, P., Tondeur, J., Braak, J. V., Duyck, W. & Duyck, P. (2011). Predicting secondary school teachers' acceptance and use of a digital learning environment: A cross-sectional study. *Computers in Human Behavior*, 27(1), 568-575.

Pynoo, B. & Duyck, P. (2012). Teachers' acceptance and use of an educational portal. *Computer & Education*, 58(4), 1308-1317.

Rahamat, R. B., Shah, P. M., Din, R. B., & Aziz, J. B. A. (2017). Students' readiness and perceptions towards using mobile technologies for learning the English language literature component. *The English Teacher*, 3, 69-84.

Rahimi, M. & Yadollahi, S. (2011). Computer anxiety and ICT integration in English classes among Ira-nian EFL teachers. *Procedia Computer Science*, 3, 203-209.

Rambe, P. & Bere, A. (2013). Using Mobile instant messaging to leverage learner participation and transform pedagogy at a South African University of Technology. *British Journal of Educationa Technology*, 44(4), 314-327.

Ramnarain, U. (2013) . The achievement goal orientation of disadvantaged physical sciences students from South Africa. *Journal of Baltic Science Education*, 12(2), 139–151.

Rasinger, S. M. (2013). *Quantitative research in lingustics: An introduction*. London: Bloomsbury Publishing Plc.

Report, S. T. (2014). *Innovate: A blueprint for science, technology, engineering, and mathematics in California public education*.. Retrieved from https://www.cde.ca.gov/pd/ca/sc/documents/innovate.pdf

Rice, P. L. & Ezzy, D. (1999). *Qualitative evaluation and research methods*, Thousand Oaks, CA: Sage.

Roberts, N. & Vänskä, R. (2011). Challenging assumptions: Mobile Learning for Mathematics Project in South Africa. *Distance Education*, 32(2), 243-259.

Robertson, M., Grady, N., Fluck, A., & Webb, I. (2006). Converstions towards effective implementation of information communication technologies in Australian schools. *Journal of Educational Administration*, 44(1), 71-85.

Saadé, R. G. & Kira, D. (2009). Computer anxiety in e-learning: The effect of computer self-efficacy. *Journal of Information Technology Education*, 8(1), 177-191.

Saba, T. (2012). Implications of e-learning systems and self-efficiency on students outcomes: a model approach. *Human-centric Computing and Information Sciences*, 2(1), 6-17.

Sad, S. N., & Goktas, O. (2014), Preservice teachers' perceptions about using mobile phones and laptops in education as mobile learning tools. British Journal of Educational Technology, 45, 606–618.

Salajan, F. D., Schonwetter, D. J., & Cleghorn, B. M. (2010). Student and faculty inter--generational digital divide: Fact or fiction? *Computers & Education*, 55(3), 1393 -1403.

Salomon, G. (1994). *Interaction of media*, *cognition and learning*, San Francisco, CA: Lawrence Erlbaum.

Sánchez-Franco, M. J. (2006). Exploring the influence of gender on the web usage via partial least squares. *Behaviour Information Technology*, 25(1), 19-36.

Sánchez-Prietoa, J. C., Hernández-Garcíab, Á., García-Peñalvoa, F. J., Chaparro-Peláezb, J. & Olmos-Migueláñeza, S. (2019). Break the walls! Second-order barriers and the acceptance of mLearning by first-year pre-service teachers. *Computers in Human Behavior*, 95(2019), 158–167.

Sapsford, R. & Jupp, V. (2006). *Data Collection and Analysis*. London: Sage.

Saroia, A. I. & Gao, S. (2018). Investigating university students' intention to use mobile learning management system. *Innovations in Education and Teaching International*.

Saunders, M., Lewis, P. & Thornhill, A. (2009). *Research methods for business students*, London: Pearson Education Limited.

Saunders, M., Lewis, P. & Thornhill, A. (2012). *Research methods for business students*, London: Pearson Education Limited.

Schoolnet, E. (2010). *Summary: Netbook pre-pilot evaluation for teachers*. Brussels, Belgium: European Schoolnet

Schumacker, R. E. & Lomax, R. G. (2016). *A Begginner's Guide to Structural Equation Modeling*, New York: Routledge.

Segall, N., Doolen, T. L. & Poter, D. J. (2005). A usability comparison of PDA-based quizzes and paper-and-pencil quizzes. *Computers & Education*, 45(4), 417-432.

Segars, A. H. & Grover, V. (1993). Re-examining perceived ease of use and usefulness: a confirmatory factor analysis. *MIS Quarterly*, *17(4)*, 517-25.

Shaqour, A. Z. (2014). Students' readiness towards M-learning: A case study of pre-service teachers in Palestine. *Journal of Educational and Social Research*, 4(6), 19-29.

Sheldon, S. B. (2003). Linking-school-family-community parternships in the urdan elementary schools to student achievement on state tests. *Urban Review*, 35, 149-158.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, 22(2004), 63-75.

Shepard, B. H., Harwick, J., & Warshaw, P. R. (1988). The theory of reasoned action: A meta-analysis of past research with recommendation for modification and future research. *Journal of Consumer Research*, 15(3), 325-343.

Shih, J. L., Chu, H. C., & Hwang, G. J. (2011). An investigation of attitudes of students and teachers about participating in a context-aware ubiquitous learning activity. *British Journal of Educational Technology*, 42(3), 373-394.

Siegel, D. M. (2008). Accepting technology and overcoming resistance to change using the motivation and acceptance model. Doctor of Philosophy, University of Central Florida.

Sivo, S. A., Ku, C.-H. & Acharya, P. (2018). Understanding how university student perceptions of resources affect technology acceptance in online learning courses. *Australasian Journal of Educational Technology*, 34(4), 72-91.

Siyam, N. (2019). Factors impacting special education teachers' acceptance and actual use of technology. *Education and Information Technologies*, 3, 1–23

Siyepu, S. (2013). The zone of proximal development in the learning of mathematics. *South African Journal of Education*, 33(2), 512-528.

Sopu, H., T , Chisaki, Y. & Usagawa, T. (2016). Use of facebook by secondary school students at nuku'alofa as an indicator of e-readiness for e-learning in the Kingdom of Tonga *International Review of Research in Open and Distributed Learning*, 17(4),1-13.

Sosik, J. J., Kahai, S. S. & Piovoso, M. J. (2009). Silver bullet or voodoo statistic? A premier for using the Partial Least Squares data analytic techniques in group and organization research. *Group & Organization Management* 34, 5-36.

Soykan, E. (2015). Views of students', teachers' and parents' on the tablet computer usage in education. Cypriot Journal of Educational Sciences. 10(3), 228-244. doi: http://dx.doi.org/10.18844/cjes.v1i1.68

Sun, H. & Zhang, P. (2006). The role of moderating factors in user technology acceptance. *International Journal of Human-Computer Studies*, 64(2), 53-78.

Tabachnick, B. G., & Fidell, L. S. (2007). Using Multivariate Statistics (5th ed.). New York: Allyn and Bacon.

Tallvid, M., Lundin, J., Svensson, L. & Lindström, B. (2015). Exploring the relationship between sanctioned and unsanctioned laptop use in a 1:1 classroom. *Educational Technology & Society*, 1(1), 162-176.

Tam, V. C. & Chan, R. M. (2009). Parental involvement in primary children's homework in Hong Kong *School Community Journal*, 19(2), 81-100.

Taylor, S. & Todd, P. A. (1995). Assessing IT usage: The role of prior experience. *MIS Quarterly*, 19(4), 561-570.

Tenenhaus, M., Vinzi, V. E., Chatelin, Y. M. & Lauro, C. (2005). PLS path modeling. *Computational statistics & data analysis*, 48(1), 159-205.

Teo, T. (2008). Pre-service teachers' attitudes towards computer use: A Singapore survey. *Australasian Journal of Educational Technology*, 24(4), 413-424.

Teo, T. (2010). A path analysis of pre-service teachers' attitudes to computer use: applying and extending the technology acceptance model in an educational context. *Interactive Learning Environments*, 18(1), 65-79.

Teo, T. (2011). Factors influencing teachers' intention to use technology: model development and test. *Computers & Education*, 57(3), 2432–2440.

Teo, T. S. H., Srivastava, S. C. & Jiang, L. (2008). Trust and electronic government success: an empirical study. *Journal of Management Information Systems*, 25(3), 99–132.

Thomas, T. D., Singh, L., & Gaffar, K. (2013) The utility of the UTAUT model in explaining mobile learning adoption in higher education in Guyana. *International Journal of Education and Development Using Information and Communication Technology (IJEDICT)*, 9(3), 71–85.

Thompson, R., Higgins, C., & Howell, J. (1991). Personal computing: Toward a conceptual model of utilization. *MIS Quarterly*, 15(1), 125-143.

Titova, S. & Avramenko, A. (2013). The evolution of learning tools in teaching foreign languages: from the personal computer to smartphones. *Linguistics and Intercultural Communication Series, 5, 25-36*

Tsuei, M. & Hsu, Y.-Y. (2019). Parents' acceptance of participation in the Integration of technology into children's instruction. *Asia-Pacific Education Research.*

Turow, J. & Nir, L. (2000). The internet and the family: The view from parent, the view from kids. Annenberg Public Policy Center, Philadelphia, PA and Washington: Annenberg Public Policy Center.

Urbach, N. & Ahlemann, F. (2010). Structural equation modeling in information systems research using Partial Least Square. *Journal of Information Technology Theory and Application*, 11(2), 5-40.

Usagawa, T. & The, M. M. (2018). Investigation of students' mobile phone usage and influences towards their mobile learning adoption: A case study in Myanmar. *International Journal of Interactive Mobile Technologies*, 12(5), 43-57.

USDOE (2017). National education technology plan. Retrieved from https://tech.ed.gov/files/2015/12/NETP16.pdf

Uzunboylu, H. & Ozdamli, F. (2011). Teacher perception for M-learning: Scale development and teachers' perceptions. *Journal of Computer Assisted Learning*, 27(6), 544-4556.

Venkatesh, V. (2000). Determinants of perceived ease of use: integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research*, 11(4), 342-365.

Venkatesh, V., Brown, S. A. & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems *MIS Quarterly*, 37(1), 21–54.

Venkatesh, V. & Davis, F. D. (1996). A model of the antecedents of perceived ease of use: Development and test. *Decision Sciences*, 27(3), 451-481.

Venkatesh, V. & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management Science*, 46(2), 186-204.

Venkatesh, V., Morris, M. G., Davis, G.B., & Davis, F. D. (2003). User acceptance of information technology: Towards a unified view. *MIS Quarterly* 27(3), 425 -478.

Venter, M., Wet, L. D. & Swart, J. 2016). Perceptions of parents and teachers of the use of mobile apps for mathematical education. *ISTE conference of mathematics*, *science and technology education,* Limpopo, South Africa. Retrieved from https://www.researchgate.net/publication/319631630

Visser, M., Juan, A., & Feza, N. (2015). Home and school resources as predictors of mathematics performance in South Africa. *South African Journal of Education*, 35(1), 1-10.

Wang, Y. S. (2007). Development and validation of a mobile computer anxiety scale. *British Journal of Educational Technology*, 38(6), 990-1009.

Wang, Y. S. & Shih, Y. W. (2008). Why do people use information kiosks? a validation of the unified theory of acceptance and use of technology. *Government Information Quarterly*, 26(1), 158-165.

Wang, Y. S., Wang, Y. M., Lin, H. H., & Tang, T. I. (2003). Determinants of user acceptance of internet banking: an empirical study. *International Journal of Service Industry Management*, 14(5), 501-19.

Wang, Y. S., Wu, M., & Wang, H. (2009). Investigating the determinants and age and gender differences in the acceptance of mobile learning. *British Journal of Educational Technology*, 40(1), 92-118.

Wasserman, E. & Zwebner, Y. (2017). Communication between teachers and parents using the WhatsApp application. *International Journal of Learning*, *Teaching and Educational Research*, 16(12), 1-12.

Wilfong, J. D. (2006). Computer anxiety and anger: The impact of computer use, computer experience, and self-efficacy beliefs. *Computers in Human Behavior*, 22(6), 1001-1011.

Yan, W. F. & Lin, Q. Y. (2005). Parent involvement and mathematics achievement: Contrast across racial and ethnic groups. *Journal of Educational Research*, 99(2), 116-127.

Yeap, J. A. L., Ramayah, T. & Soto-Acosta, P. (2016). Factors propelling the adoption of M-learning among students in higher education. *Electronic Markets*, 26(4), 323–338

Yeop, M. A., Yaakob, M. F. M., Wong, K. T., Don, Y. & Zain, F. M. (2019). Implementation of ICT policy (Blended Learning Approach): Investigating factors of behavioural intention and use behaviour. *International Journal of Instruction*, 12(1), 767-782.

Yi, M. Y. & Hwang, Y. (2003). Predicting the use of web-based information systems: self-efficacy, enjoyment, learning goal orientation, and the technology acceptance model *International Journal of Human-Computer Studies*, 59, 431-346.

Yorganci, S. (2017). Investigating students' self-efficacy and attitudes towards the use of mobile learning. *Journal of Education and Practice*, 8, 181-185.

Yusri, I. K., Goodwin, R. & Mooney, C. (2014). Teachers and mobile learning perception: towards a conceptual model of mobile learning for training. *Social and Behavioral Sciences,* 176(2015), 425 – 430.

Zalah, I. (2018). Factors that influence Saudi secondary teachers' acceptance and use of e-learning technologies. Doctor of Philosophy, University of Brighton.

Zhang, M., Liu, Y., Yan, W. & Zhang, Y. (2016). Users' continuance intention of virtual learning community services: The moderating role of usage experience. *Interactive Learning Environments*, *2(1),* 1–19.

Zheng, B., Warschauer, M., Lin, C. H. & Chang, C. (2016). Learning in one-to-one laptop environments: A meta-analysis and research synthesis. *Review of Educational Research*, 86(4), 1052-1084.

Zhu, S., Yang, H. H., Macleod, J., Shi, Y. & Wu, D. (2018). Parents' and students' attitudes toward tablet integration in schools. *International Review of Research in Open and Distributed Learning*, 19(4), 222-241.

APPENDICES

Appendix 1: Proof of Registration

Page 1 of 1

Proof Of Registration

No : 201640095
30-MAY-2019

Name: Mr D Mutambara
P.O Box 1180

Esikhawini
3887

Qualifications And Subjects

Code		Amount	
EDED11	D.ED (MATHEMATICS, SCIENCE &	3500.00	D
EST800	D ED (MATHEMATICS, SCIENCE AND	0.00	D

Ref Other Transactions

Total For This Registration 3500.00 D

This only reflects costs for this registration.
This is not a statement of the account.

Appendix 2: Ethical Clearance Certificate

UNIVERSITY OF ZULULAND
RESEARCH ETHICS COMMITTEE
(Reg No: UZREC 171110-030)

RESEARCH & INNOVATION
Website: http://www.unizulu.ac.za
Private Bag X1001
KwaDlangezwa 3886
Tel: 035 902 6731
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ETHICAL CLEARANCE CERTIFICATE

Certificate Number	UZREC 171110-030 PGD 2019/29
Project Title	DETERMINANTS OF MOBILE LEARNING ACCEPTANCE AMONG GRADE 12 LEARNERS, THEIR PARENTS AND TEACHERS IN RURAL KING CETSHWAYO DISTRICT
Principal Researcher/ Investigator	D Mutambara
Supervisor and Co-supervisor	Prof A. Bayaga
Department	Maths, Science and Technology Education
Faculty	Education
Type of Risk	Med Risk – Data collection from people
Nature of Project	Honours/4th Year ☐ Master's ☐ Doctoral x Departmental ☐

The University of Zululand's Research Ethics Committee (UZREC) hereby gives ethical approval in respect of the undertakings contained in the above-mentioned project. The Researcher may therefore commence with data collection as from the date of this Certificate, using the certificate number indicated above.

Special conditions:

(1) This certificate is valid for 1 year from the date of issue.
(2) Principal researcher must provide an annual report to the UZREC in the prescribed format [due date-03 October 2020]
(3) Principal researcher must submit a report at the end of project in respect of ethical compliance.
(4) The UZREC must be informed immediately of any material change in the conditions or undertakings mentioned in the documents that were presented to the meeting.

The UZREC wishes the researcher well in conducting research.

Professor Gideon De Wet
Chairperson: University Research Ethics Committee
Deputy Vice-Chancellor: Research & Innovation

04 October 2019

CHAIRPERSON
UNIVERSITY OF ZULULAND RESEARCH ETHICS COMMITTEE (UZREC)
REG NO: UZREC 171110-30
04 -10- 2019
RESEARCH & INNOVATION OFFICE

Appendix 3: Learners’ Questionnaire

Leaners’ Questionnaire

The purpose of the questionnaire is to collect data that will be used to determine the determinants of mobile learning acceptance among grade 12 Sciences, Mathematics, Engineering and Technology (STEM) learners in the rural King Cetshwayo District. Any information provided will be treated with utmost confidentiality and will not be used for any other uses other than its purpose. It is not compulsory to take part in this questionnaire, and participants can withdraw at any time without consequences. All data obtained from participants and their personal details will be kept anonymous.

Time needed to complete this question paper is 15 minutes.

Definitions **Mobile Learning (M-learning): learning which takes place via wireless devices such as Smart Phones, PDAs, and Tablet PCs. These devices are mobile and will allow learning to take place anytime, anywhere. STEM: this is a combination of all science subjects, engineering subjects and mathematics**

Background Information

Tick the box that is applicable to you.

Gender	Male		Female			
Residential demographic:	Rural		Urban		Semi-Urban	
Subject specialization:	Mathematics					
	Sciences					

SECTION B

Number 1 to 5 represent the following:

1: Strongly disagree 2: Disagree 3. Somewhat disagree 4: neutral 5: Somewhat agree 6: Agree 7: Strongly agree

Please indicate your level of agreement/disagreement with the following:

Perceived resources

No	Statement	1	2	3	4	5	6	7
1	I have the mobile learning resources I would need to use for learning STEM.							
3	I would be able to use mobile learning for learning STEM if I wanted to							
4	I have access to the resources I would need to use mobile learning for learning STEM							
5	I have a mobile device that I can use to learn STEM							
6	I can get help from others when I have difficulties using Mobile Learning for learning STEM							

Perceived usefulness:

No	Statement	1	2	3	4	5	6	7
1	Using mobile learning in class will improved my work efficiency in learning STEM							
2	Using mobile learning to learn STEM will enhance the quality of my learning							
3	Using mobile learning to learn STEM would increase my productivity							
4	Using mobile learning would enhance my effectiveness in learning STEM							
5	Using mobile learning would make it easier for me to learn STEM							
6	I would find mobile learning useful in learning STEM.							

Perceived Skills readiness

No	Statement	1	2	3	4	5	6	7
1	I have the skills I would need to learn STEM using mobile learning							
2	I can use a mobile phone to download applications from the Internet							
3	I can use a mobile phone to access information/services on the internet							

Perceived ease of use

No	Statement	1	2	3	4	5	6	7
1	It will be easy to learn how to use mobile learning to learn STEM							
2	I will find it easy to use mobile learning to teach STEM.							
3	I will find mobile learning easy to use in STEM class							
4	I would find mobile learning to be flexible to interact with.							
5	It will be easy for me to become skilful in learning STEM using mobile learning							

Perceived Attitude:

No	Statement	1	2	3	4	5	6	7
1	I believe it is beneficial to use mobile learning to learn STEM							
2	My experience with mobile learning to learn STEM will be good							
3	I feel positive about using mobile learning for learning STEM							
4	The mobile learning application will improve my online learning experience							

Perceived Behaviour intention to use

No	Statement	1	2	3	4	5	6	7
1	Assuming I have access to mobile learning, I intend to use it to learn STEM							
2	I will frequently learn STEM using mobile learning in the future.							
3	I would like to use many different mobile applications for learning STEM in the future							
4	It is worth it to use mobile learning for learning STEM							
5	I am planning to use mobile learning in learning STEM							

Perceived ease to collaborate

No	Statement	1	2	3	4	5	6	7
1	Learning to collaborate using mobile learning would be easy for me							
2	I would find it easy to learn with others using mobile learning							
3	I would find it easy to work in groups using mobile learning							

Perceived enjoyment

No	Statement	1	2	3	4	5	6	7
1	learning STEM using mobile learning would be enjoyable							
2	I would find it fun to learn STEM using mobile learning							
3	I would find using mobile learning interesting							

Perceived Psychological readiness

No	Statement	1	2	3	4	5	6	7
1	Mobile device (like a phone) is difficult to use							
2	Mobile device (like a phone) frustrates me							
3	I feel insecure about my ability to use learn STEM using mobile device (like a phone)							
4	I need someone to tell me the best way to learn STEM using mobile device (like a phone)							

Perceive Social influence.

No	Statement	1	2	3	4	5	6	7
1	My friends think that I should use mobile learning for learning STEM							
2	Learners' parents think that I should use mobile learning for learning STEM							
3	My learners think that I should use mobile learning for learning STEM							
4	My workmates think that I should use mobile learning for learning STEM							

Appendix 4: Teachers' Questionnaire

Teachers' Questionnaire

The purpose of the questionnaire is to collect data that will be used to determine the determinants of mobile learning acceptance among grade 12 Sciences, Mathematics, Engineering and Technology (STEM) teachers in the rural King Cetshwayo District. Any information provided will be treated with utmost confidentiality and will not be used for any other uses other than its purpose. It is not compulsory to take part in this questionnaire, and participants can withdraw at any time without consequences. All data obtained from participants and their personal details will be kept anonymous.

Time needed to complete this question paper is 15 minutes.

Definitions

Mobile Learning (M-learning): learning which takes place via wireless devices such as Smart Phones, PDAs, and Tablet PCs. These devices are mobile and will allow learning to take place anytime, anywhere.

STEM: this is a combination of all science subjects, engineering subjects and mathematics

Background Information

Tick the box that is applicable to you.

Gender	Male		Female			
Residential demographic:	Rural		Urban		Semi-Urban	
Subject specialization:	Mathematics					
	Sciences					

SECTION B

Number 1 to 5 represent the following:

1: Strongly disagree 2: Disagree 3. Somewhat disagree 4: neutral 5: Somewhat agree 6: Agree 7: Strongly agree

Please indicate your level of agreement/disagreement with the following

Perceived resources

No	Statement	1	2	3	4	5	6	7
1	I have the mobile learning resources I would need to use for teaching STEM.							
2	I would be able to use mobile learning for teaching STEM if I wanted to							
3	I have access to the resources I would need to use mobile learning for teaching STEM							
4	I can get help from others when I have difficulties using Mobile Learning for teaching STEM							

Perceive usefulness:

No	Statement	1	2	3	4	5	6	7
1	Using mobile learning in class will improved my work efficiency in teaching STEM							
2	Using mobile learning to teach STEM will enhance the quality of my work							
3	Using mobile learning to teach STEM would increase my productivity							
4	Using mobile learning would make it easier for me to teach STEM							
5	I would find mobile learning useful in teaching STEM.							

Perceived Skills readiness

No	Statement	1	2	3	4	5	6	7
1	I have the skills I would need to teach STEM using mobile learning							
2	I can use a mobile phone to download applications from the Internet							
3	I can use a mobile phone to access information/services on the internet							

1: Strongly disagree 2: Disagree 3. Somewhat disagree 4: neutral 5: Somewhat agree 6: Agree 7: Strongly agree

Perceived ease of use

No	Statement	1	2	3	4	5	6	7
1	It will be easy to learn how to use mobile learning to teach STEM							
2	I will find it easy to use mobile learning to teach STEM.							
3	I will find mobile learning easy to use in STEM class							
4	I would find mobile learning to be flexible to interact with.							
5	It will be easy for me to become skilful in teaching STEM using mobile learning							

Perceived Attitude:

No	Statement	1	2	3	4	5	6	7
1	I believe it is beneficial to use mobile learning to teach STEM							
2	My experience with mobile learning to teach STEM will be good							
3	I feel positive about using mobile learning for teaching STEM							
4	The mobile learning application will improve my online learning experience							
5	I would like to use many different mobile applications for teaching STEM in the future							

Perceived Behaviour intention to use

No	Statement	1	2	3	4	5	6	7
1	Assuming I have access to mobile learning, I intend to use it to teach STEM							
2	I will frequently teach STEM using mobile learning in the future.							
3	I am planning to use mobile learning in teaching STEM							

Perceived ease to collaborate

No	Statement	1	2	3	4	5	6	7
1	Learning to collaborate using mobile learning would be easy for me							
2	I would find it easy to work with others using mobile learning							
3	I would find it easy to work in group/clusters using mobile learning							

Perceived enjoyment

No	Statement	1	2	3	4	5	6	7
1	Teaching STEM using mobile learning would be enjoyable							
2	I would find it fun to teach STEM using mobile learning							
3	I would find using mobile learning interesting							

Perceived Psychological readiness

No	Statement	1	2	3	4	5	6	7
1	Mobile device (like a phone) is difficult to use							
2	Mobile device (like a phone) frustrates me							
3	I feel insecure about my ability to use teach STEM using mobile device (like a phone)							
4	I need someone to tell me the best way to teach STEM using mobile device (like a phone)							

Perceive Social influence.

No	Statement	1	2	3	4	5	6	7
1	My friends think that I should use mobile learning for teaching STEM							
2	Learners' parents think that I should use mobile learning for teaching STEM							
3	My learners think that I should use mobile learning for teaching STEM							

Appendix 5: Parents' Questionnaire

Parents' Questionnaire

The purpose of the questionnaire is to collect data that will be used to determine the determinants of mobile learning acceptance among parents of grade 12 Sciences, Mathematics, Engineering and Technology (STEM) learners in the rural King Cetshwayo District. Any information provided will be treated with utmost confidentiality and will not be used for any other uses other than its purpose. It is not compulsory to take part in this questionnaire, and participants can withdraw at any time without consequences. All data obtained from participants and their personal details will be kept anonymous.

Time needed to complete this question paper is 15 minutes.

Definition

Mobile Learning (M-learning): learning which takes place via wireless devices such as Smart Phones, PDAs, and Tablet PCs. These devices are mobile and will allow learning to take place anytime, anywhere.

STEM: this is a combination of all science subjects, engineering subjects and mathematics

Background Information

Tick the box that is applicable to you.

Gender	Male		Female			
Residential demographic:	Rural		Urban		Semi-Urban	

SECTION B

Number 1 to 5 represent the following:

1: Strongly disagree 2: Disagree 3. Somewhat disagree 4: neutral 5: Somewhat agree 6: Agree 7: Strongly agree

Please indicate your level of agreement/disagreement with the following

Perceived resources

	Statement	1	2	3	4	5	6	7
1	I have the mobile learning resources my child would need to use for learning STEM.							
2	My child would be able to use mobile learning for learning STEM if he/she wanted to							
3	I have access to the resources my child would need to learn STEM using mobile learning							
4	My child can get help from others when he/she have difficulties using mobile learning for learning STEM							

Perceive usefulness:

No	Statement	1	2	3	4	5	6	7
1	Using mobile learning in class will improved my child's efficiency in teaching STEM							
2	Using mobile learning to learn STEM will enhance her/his quality of my work							
3	Using mobile learning to learn STEM would increase her/his productivity							
4	Using mobile learning would make it easier for my child to learn STEM							
5	My child will find mobile learning useful for learning STEM.							

Perceived Skills readiness

No	Statement	1	2	3	4	5	6	7
1	My child has the skill to learn STEM using mobile learning							
2	My child can use mobile phone to download applications from the Internet							
3	My child can use a mobile phone to access information/services on the internet							

1: Strongly disagree 2: Disagree 3. Somewhat disagree 4: neutral 5: Somewhat agree 6: Agree 7: Strongly agree

Perceived ease of use

No	Statement	1	2	3	4	5	6	7
1	It will be easy for my child to learn how to use mobile learning to learn STEM							
2	My child will find it easy to use mobile learning to learn STEM.							
3	My child will find mobile learning easy to use in STEM class							
4	My child would find mobile learning to be flexible to interact with.							
5	It will be easy for my child to become skilful in using mobile learning to learn STEM							

Perceived Attitude

No	Statement	1	2	3	4	5	6	7
1	I believe it is beneficial for my child to use mobile learning to learn STEM							
2	My child's experience with mobile learning to learn STEM will be good							
3	I feel positive for my child to use mobile learning for teaching STEM							
4	The mobile learning application will improve my child's online learning experience							
5	I would like my child to use many different mobile applications for learning STEM in the future							

Perceived Behaviour intention to use

No	Statement	1	2	3	4	5	6	7
1	Assuming my child have access to mobile learning, I intend to let her/him to use it to learn STEM							
2	My child will frequently learn STEM using mobile learning in the future.							
3	I am planning form my child to use mobile learning in learning STEM							

Perceived ease to collaborate

No	Statement	1	2	3	4	5	6	7
1	Learning to collaborate using mobile learning would be easy for me							
2	I would find it easy to work with others using mobile learning							
3	I would find it easy to work in group/clusters using mobile learning							

Perceived enjoyment

No	Statement	1	2	3	4	5	6	7
1	Learning STEM using mobile learning would be enjoyable for my child							
2	My child would find it fun to learn STEM using mobile learning							
3	My child would find using mobile learning interesting							

Perceived Psychological readiness

No	Statement	1	2	3	4	5	6	7
1	Mobile device (like a phone) is difficult to use							
2	Mobile device (like a phone) frustrates me							
3	My child feels insecure about his/her ability to use teach STEM using mobile device (like a phone)							
4	My child needs someone to tell him/her the best way of learning STEM using mobile device (like a phone)							

Perceive Social influence.

No	Statement	1	2	3	4	5	6	7
1	My friends think that my child should use mobile learning for teaching STEM							
2	My child’s teachers think that he/she should use mobile learning for teaching STEM							
3	Other parents at the school think that my child should use mobile learning for learning STEM							

Appendix 6: Interview Schedule

Interview Schedule for rural high school STEM learners, their parents, and teachers

Introductions, check participants know what the interview is about and how long it will take, ask about recording, check that the time is convenient and ascertain appropriate demographic and school details.

Questions for interview

What is M-learning?

What are the devices used for M-learning?

What is STEM?

Does your attitude towards the use of mobile learning affect your intention to use it?

Does what other people around you say about mobile learning influence your decision to use mobile learning?

Do the benefits of mobile learning influence your decision to use it?

Does the availability of resources influence your decision to use mobile learning?

Does the effort needed to learn to use mobile learning affect your decision to use it?

Does perceived enjoyment influence your decision to use mobile learning.

Does perceived ease to collaborate influence your behavioural intention to use mobile learning

ANNEXURES

ANNEXURE A: Permission to Conduct Research in Schools

University of Zululand
Private bag X1001
KwaDlangezwa
3886
Tel 035 902 6220
Email: vadmutambara@gmail.com
25 March 2019

The Director: Research Strategy Development and ECMIS
KZN Department of Education
Private Bag X9137
PIETERMARITZBURG
3200

Dear Sir/Madam

A REQUEST FOR PERMISSION TO CONDUCT RESEARCH WITH GRADE 12 LEARNERS AND THEIR TEACHERS AS SUBJECTS

I am a student conducting research for Doctoral of Education degree in the Faculty of Education at the University of Zululand. I am writing this letter to request for permission to conduct research with grade 12 learners and their teachers in King Cetshwayo District. My research interest is on the acceptance of mobile learning in the district.

The aims of the study are:

1. To investigate the level of grade 12 learners' readiness for mobile learning.
2. To find out the factors that influence grade 12 learners' acceptance of mobile learning.

3. To find out the factors that affect grade 12 learners' teachers' acceptance of mobile.
4. To find out the factors that influence grade 12 learners' parents' acceptance of mobile learning.
5. To find out if there are significant differences between grade 12 learners', their teachers', and parents' attitudes towards mobile learning.

Your consideration of this letter and granting of permission to do research will be greatly appreciated.

Yours sincerely

David Mutambara

<u>SUPERVISOR</u>

PROF. A. BAYAGA

ANNEXURE B: Permission Letter for School Principals

University of Zululand

Private bag X1001

KwaDlangezwa

3886

Tel 035 902 6220

Email: davidmutabara@gmail.com

The Principal

King Cetshwayo District

KZN

Dear Sir/Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH WITH GRADE 12 LEARNERS AND THEIR TEACHERS AS SUBJECTS

I am a student conducting research for Doctoral of Education degree in the Faculty of Education at the University of Zululand. I am writing this letter to request for permission to conduct research with grade 12 learners and their teachers in King Cetshwayo District. My research interest is on the acceptance of mobile learning in the district

The aims of the study are:

1. To investigate the level of grade 12 learners' readiness for mobile learning.
2. To find out the factors that influence grade 12 learners' acceptance of mobile learning in high schools.
3. To find out the factors that affect grade 12 teachers' acceptance of mobile.
4. To find out the factors that influence grade 12 learners' parents' acceptance of mobile learning.
5. To find out if there are significant differences between grade 12 learners', their teachers, and parents' attitudes towards mobile learning.

Your consideration of this letter and granting of permission to do research will be greatly appreciated.

Yours sincerely

David Mutambara

Prof. A. Bayaga (Supervisor)

RESPONSE

I do/ do not give permission to conduct research in …………………………..………school.

___________________________PRINCIPAL (…………………………..………… School)

ANNEXURE C: Participant Consent Letter

Dear Teacher/Participant

You are requested to take part in a research study. It is important that you should have some general understanding of what the research is about. Please take time to carefully read the following message.

This study is about the acceptance of mobile learning by grade 12 learners, their teachers, and parents in rural areas of King Cetshwayo District. The general outcome of this research study will be shared with the Department of Basic Education and will be used to improve the implementation of mobile learning in rural areas of Kind Cetshwayo District. You are assured that all information you provide will be strictly kept confidential, therefore do not write your name of your school on the questionnaire.

By signing this consent form, I confirm that I have read and understood the information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I voluntarily agree to take part in this study.

NAME: ____

Signature: ________________________________ Date: ________________________

Thank you for your participation and cooperation in this research study.

David Mutambara

University of Zululand

Faculty of Education

Department of Educational Maths, Science and Technology Education

Private bag X1001

KwaDlangezwa

3886

ANNEXURE D1: Participant Informed Consent Declaration (English)

Project Title: Determinants of mobile learning acceptance among grade 12 learners, their parents, and teachers in the rural King Cetshwayo District

David Mutambara from the Department of Education, University of Zululand has requested my permission to participate in the above-mentioned research project.

The nature and the purpose of the research project, and of this informed consent declaration have been explained to me in a language that I understand.

I am aware that:

The purpose of the research project is to find the determinants of mobile learning acceptance in the rural King Cetshwayo District

1. The University of Zululand has given ethical clearance to this research project and I have seen/ may request to see the clearance certificate.

2. By participating in this research project, I will be contributing towards Successful implementation of mobile learning in South Africa

3. I will participate in the project by completing the questionnaire

4. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.

5. I will not be compensated for participating in the research, but my out-of-pocket expenses will be reimbursed.

6. There may be risks associated with my participation in the project. I am aware that the following risks are associated with my participation: None

   a. the following steps have been taken to prevent the risks: N/A

   b. there is a 0% chance of the risk materializing

7. The researcher intends publishing the research results in the form of

   PHD Thesis and articles. However, confidentiality and anonymity of records will be maintained and that my name and identity will not be revealed to anyone who has not been involved in the conduct of the research.

   I will not receive feedback/will receive feedback in the form of workshops regarding the results obtained during the study.

8. Any further questions that I might have concerning the research, or my participation will be answered by……………… (***provide name and contact details***)

9. By signing this informed consent declaration, I am not waiving any legal claims, rights, or remedies.

10. A copy of this informed consent declaration will be given to me, and the original will be kept on record.

I, ………………………………………………………………………….. have read the above information / confirm that the above information has been explained to me in a language that I understand, and I am aware of this document's contents. I have asked all questions that I wished to ask, and these have been answered to my satisfaction. I fully understand what is expected of me during the research.

I have not been pressurized in any way and I voluntarily agree to participate in the abovementioned project.

…………………………………	…………………………………
Participant's signature	**Date**

ANNEXURE D2: Participant Informed Consent Declaration (isiZulu)

IFOMU LOKUZIBOPHEZELA

(obambe iqhaza) Isihloko socwaningo:

-

.... (**igama lomcwaningi/lomuntu oxhumanise izinsiza zocwaningo**) ovela ku Mnyango ……......................................, University of Zululand ube nesicelo semvume yokuzibandakanya kulolucwaningo olulotshwe ngenhla.

Imvelaphi kanye nenhloso yalolucwaningo, nalolu lwazi nophawu lokwamukela ukuzibophezela ngichazeliwe ngalo ngolimi engilwaziyo. Ngiyakuqonda ukuthi:

1. Inhloso yalolucwaningo uku ……………………………….

2. Inyuvesi yakwaZulu inikezele ngemvume kubenzi balolu cwaningo ukuba benze loluhlelo futhi ngiyibonile leyomvume/ngingacela ukubona isitifiketi semvume.

3. Ngokubamba iqhaza kulolucwaningo ngizonikezela iqhaza ngoku ……………………………… **(chaza ubungako obulindelekile noma inzuzo emphakathini noma abantu abangaphumelela ngalolucwaningo)**

4. Ngizobamba iqhaza kulolucwaningo ngoku ……………………………… **(chaza imininingwane ephelele yokuthi ozimbandakanyile uzobe enzani)**

5. Ekuzibandakanyeni kwami angizukubheka nzuzo futhi akukho lapho engizotholakala ngihoxa ocwaningweni, umakwenzeka ngeke kube nemiphumela emibi ocwaningeni.

6. Mina angizukunxephezelwa ngokuzibandakanya kwami kulolucwaningo, kodwa izindleko ephume kwelami iphakethe zizokhokhelwa. **(Uma kukhona isinxephezelo nikeza imininingwane)**.

7. Kuzoba nezimo ezibucayi ekuzibandakanyeni kwami kulolucwaningo, ngiyakuqonda ukuthi:
   a. Lobu bungozi obulandelayo kuxhumene nokuzimbadakanya kwami ………………………… **(chaza imininingwane yonke ngobungozi okungaba khona kumuntu ozimbandakanye nalolucwaningo**).
   b. Lezi zitebhu ezilandelayo zithathiwe ukuvikela ubungozi: …………
   c. Angu ………… % amathuba okuvela kobungozi.

8. Umphequluli uzoshicilela imiphumela yalolucwaningo ngohlelo loku………………………. Nokho, ubhalomfihlo, nofihlo-gama lwemininingwane izobe igciniwe nokuthi igama lami nobutho kwami angeke kubonakaliswe kumona yimuphi umuntu obengayona inhlangano yocwaningo.

9. Angeke ngiyamukele imiphumela/ngizoyamukela imiphumela engaloluhlelo……………….. emayelana nemiphumela etholakale ngesikhathi sesifundo.

10. Eminye imibuzo ephathelene nalolucwaningo noma mayelana nokuzibandakanya kwami ingaphendulwa ngu …………………………………… **(bhala igama neminininingwane yokuxhumana).**

11. Ngokusayina lamafomu angiqubuli ubuthi noma amalungelo kwezomthetho.

12. Ikhophi enolwazi oluphelele nophawu lokwamukela ukuzibophezela kwami ngizonikezwa, bese okungungqo kuyagcinwa.

Mina ……………………………….ngilufundile loku okubhalwe ngenhla/ ngiyavuma ukuthi lolulwazi olungenhla ngichazelwe ngolimi lwami engiluqondayo futhi ngiyakuqonda okuqukethwe nokubhaliwe. Ngiyibuze yonke imibuzo engifunayo ukuyibuza, futhi yaphendulwa ngendlela engenelisayo. Ngiyayiqonda kahle ukuba kulindelekile ini kimi kulolucwaningo.

Angiphoqwanga nakancane ukubamba iqhaza kulokhu kulolucwaningo

--------------------------------------	--------------------------------------
isishicilelo kobambe iqhaza	**usuku**

ANNEXURE E1: Parent's/guardian's Informed Consent Declaration (English)

INFORMED CONSENT DECLARATION

(Parent or Guardian)

Project Title: Determinants of mobile learning acceptance among grade 12 learners, their parents, and teachers in the rural King Cetshwayo District. David Mutambara from the Department of Education, University of Zululand has requested my permission to allow my child/ ward to participate in the above-mentioned research project.

The nature and the purpose of the research project, and of this informed consent declaration have been explained to me in a language that I understand.

I am aware that:

1. The purpose of the research project is to determine the determinants of mobile learning acceptance among grade 12 learners, their parents, and teachers in the rural King Cetshwayo District.

2. The University of Zululand has given ethical clearance to this research project and I have seen/ may request to see the clearance certificate.

3. By participating in this research project my child/ward will be contributing towards successful implementation of mobile learning in South Africa

4. My child/ward will participate in the project by completing the questionnaire

5. My child’s/ward’s participation is entirely voluntary and if my child/ward is older than seven (7) years, s/he must also agree to participate.

6. Should I or my child/ward at any stage wish to withdraw my child/ward from participating further, we may do so without any negative consequences.

7. My child/ward may be asked to withdraw from the research before it has finished if the researcher or any other appropriate person feels it is in my child’s/ward’s best interests, or if my child/ward does not follow instructions.

8. Neither my child/ward nor I will be compensated for participating in the research. (***Should there be compensation***, ***provide details***)

9. There may be risks associated with my child’s/ward’s participation in the project. I am aware that:

   a. the following risks are associated with participation: None

   b. the following steps have been taken to prevent the risks: None

   c. there is a 0% chance of the risk materializing.

10. The researcher intends publishing the research results in the form of articles and a thesis. However, confidentiality and anonymity of records will be maintained and that my or my child’s/ward’s name and identity wiIl not be revealed to anyone who has not been involved in the conduct of the research.

11. I will not receive feedback/will receive feedback in the form of workshop regarding the results obtained during the study.

12. Any further questions that I might have concerning the research or my participation will be answered by……………… (***provide name and contact details***)

13. By signing this informed consent declaration, I am not waiving any legal claims, rights, or remedies that I or my child/ward may have.

14. A copy of this informed consent declaration will be given to me, and the original will be kept on record.

I, ……………………………………………………………………….. have read the above information / confirm that the above information has been explained to me in a language that I understand and I am aware of this document's contents. I have asked all questions that I wished to ask, and these have been answered to my satisfaction. I fully understand what is expected of my child/ward during the research.

I have not been pressurized in any way to let my child/ward take part.

By signing below, I voluntarily agree that my child/ward …………………………………………………………(**insert name of child/ward**), who is …………….. years old, may participate in the abovementioned research project.

ANNEXURE E1: Parent's /guardian's Informed Consent Declaration (isiZulu)

INCWADI EVEZA IGUNYA LOMZALI UKUTHI UMNTWANA ABAMBE IQHAZA

(Umzali noma onegunya lokunakekela umntwana)

Isihloko:

Mr David Mutambara osophikweni lweMathematics, Science and Technology Education (MSTE) enyuvesi yakwaZulu (Ongoye) ucela imvume yami ukuhlanganyela ocwaningweni lwakhe olukusihloko esingenhla.

Inqubo nomgomo walolu cwaningo, nalesi sivumelwano luchazwe ngolimi engilwaziyo.

Ngiyaqonda ukuthi:

1. Inhloso yalolucwaningo:
2. I University of Zululand iluvumele lolucwaningo.
3. Ngokuzimbandakanya nalo lucwaningo umntwana wami angasiza ekwenzeni ngcono le ndlela yokufundisa ngoku 'hlolelwa kokufunda' lapho kunesidingo sokuba umfundi anikezwe ithuba lokuveza, aziswe ngokufunda kwakhe, kwenye ingxenye uthisha aqhubeke abahlole imisebenzi yabafundi anyakazise nezindlela zokwenza ukuze ahlangabezane nezidingo zabo.
4. Umntwana wami uzozimbandakanya kulolu ucwaningo ngokuphendula imibuzo bebhekene, imibuzo esephepheni nano kuhlowa okungatheni.
5. Umntwana wami uzivumele yena ukuba ingxenye yalolu cwaningo futhi uneminyaka engaphezu kweyisikhombisa.
6. Uma mina noma umntwana wami engasathandi ukuba ingxenye yalo, uyohoxa engalindelwa zinkinga ngokuhoxa kwakhe.

7. Umntwana wami angacelwa ukuthi ahoxe ngaphambi kokuphela kocwaningo uma umcwaningi noma ubani omunye ophathelene nalo ebona kufanele noma engalandeli imigomo yalo.

8. Mina nomntwana wami asilindele muholo/mhlomulo ngokuba yingxenye yalolu cwaningo.

9. Angilindele bungozi obungahambisana nalolu cwaningo, akesibheke ukuthi kokulandelayo kungenzeka yini:

   a) Ingozi ehlobene nokuhlanganyela kwakhe? –**Ayikho ingozi eyaziwayo engenzeka ngalesi sikhathi.**

   b) Izinyathelo ezothathwa uma kungenzeka ukube nobungozi - **Azikho (ngoba imibuzo yodwa).**

   c) Kukhona ingozi engu 0% engenzeka ngalesi sikhathi - **Ayikho**

10. Umcwaningi ufisa ukulushicilela lolu cwaningo lube umqingo wencwadi eqikelela ukuthi igama lomntwana wami, nemi niningwane yakhe kuyohlala kuyimfihlo.

11. Ngingathanda/ngingethande ukuzwa ngemiphumela yocwaningo ngokufunda lowo mqingo ozoyoshicilelwa.

12. Imibuzo engingaba nayo mayelana nalolu cwaningo iyophendulwa umcwaningi uqobo ogama lakhe ngu.

13. Ngokuzinikela kwami ekusayineni leli fomu angizibophezeli ekutheni ngingethathe izinyathelo okungaba ezomthetho noma ukunxeshezelwa komntwana wami.

14. Ngizogcina ikhophi yaleli fomu lokuzibophezela bese lona ligcinwe nguye umcwaningi. Mina…………………………….. ngiyifundile yonke imininingwane ekuleli fomu futhi ngichazelwe yona ngolimi engilulwaziyo. Ngiyakwazi okubhalwe kuleli fomu. Ngibuze yonke imibuzo ebengingaba nayo ngaphenduleka ngendlela engenelisayo. Ngiyazi konke okulindeleke kumntwana wami ngesikhathi salolu mcwaningo.

Angifakwanga ingcindezi, ngizingenele mina ngokuthanda kulolu cwaningo. Ngokusayina ngiyazivumela mina ukuthi umntwana wami u ……………………………….… oneminyaka engu………………angazimbandakanya nalolucwaningo.

Isiginesha…………………………………… Usuku…………………….

ANNEXURE F: Informed Consent Declaration (English)

(Child participant)

Project Title: ***Determinants of mobile learning acceptance among grade 12 learners*****,** ***their parents, and teachers in the rural King Cetshwayo District***

Researcher's name: David Mutambara

Name of participant: ………………………………………………………………………

1. Has the researcher explained what s/he will be doing and wants you to do?

YES	NO

2. Has the researcher explained why s/he wants you to take part?

YES	NO

3. Do you understand what the research wants to do?

YES	NO

4. Do you know if anything good or bad can happen to you during the research?

YES	NO

5. Do you know that your name and what you say will be kept a secret from other people?

YES NO

6. Did you ask the researcher any questions about the research?

YES NO

7. Has the researcher answered all your questions?

YES NO

8. Do you understand that you can refuse to participate if you do not want to take part and that nothing will happen to you if you refuse?

YES NO

9. Do you understand that you may pull out of the study at any time if you no longer want to continue?

YES NO

10. Do you know who to talk to if you are worried or have any other questions to ask?

YES NO

11. Has anyone forced or put pressure on you to take part in this research?

YES NO

12. Are you willing to take part in the research?

YES	NO

______________________________ ______________________________

Signature of Child **Date**

Annexure G: DoE Letter of Permission

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Phindile Duma/Buyi Ntuli **Tel:** 033 392 1063/51 **Ref.**:2/4/8/4024

Mr David Mutambara
P.O. Box 2384
RICHARDS BAY
3900

Dear Mr Mutambara

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"DETERMINANTS OF MOBILE LEARNING ACCEPTANCE AMONG GRADE 12 LEARNERS, THEIR PARENTS AND TEACHERS IN THE RURAL KING CETSHWAYO DISTRICT"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 15 January 2020 to 10 January 2022.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

KING CETSHWAYO DISTRICT

Dr. EV Nzama
Head of Department: Education
Date: 15 January 2020

...Championing Quality Education - Creating and Securing a Brighter Future

KWAZULU-NATAL DEPARTMENT OF EDUCATION
Postal Address: Private Bag X9137 • Pietermaritzburg • 3200 • Republic of South Africa
Physical Address: 247 Burger Street • Anton Lembede Building • Pietermaritzburg • 3201
Tel.: +27 33 392 1063 • **Fax.:** +27 033 392 1203• **Email:**Phindile.Duma@kzndoe.gov.za •**Web:**www.kzneducation.gov.za
Facebook: KZNDOE….Twitter: @DBE_KZN….Instagram: kzn_education….Youtube:kzndoe

Annexure H: Editor's Certificate

Helen Bond

IMPELA EDITING SERVICES

impelaediting@gmail.com

079 395 5873

20 January 2020

CERTIFICATE

David Mutambara

vadmutambara@gmail.com

Dear David

Thank you for using Impela Editing Services to proofread your PhD thesis entitled, "*Determinants of mobile learning acceptance among rural grade 12 STEM learners, their parents and teachers in the rural King Cetshwayo District*".

We have proofread for errors of grammar, punctuation, spelling, syntax and typing mistakes. We have formatted your work, updated all digital table of contents, and checked the references (this means checking the formatting).

Please note that Impela Editing does not accept any fault for changes made to a document after emailing the final draft and issuing a certificate.

I wish you the very best in your submission and in your career.

Kind regards

H Bond

Helen Bond (Bachelor of Arts, HDE)

Annexure I: Turn-It-In Report

Determinants of mobile learning acceptance among rural grade 12 STEM learners, their parents and teachers in the rural King Cetshwayo District

ORIGINALITY REPORT

6%	6%	3%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	cris.brighton.ac.uk Internet Source	2%
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Annexure J: Publication

Understanding Rural Parents' Behavioural Intention to Allow their Children to Use Mobile Learning

Abstract. Faced with many challenges resulting in learners' poor performance at matriculation level, emphasis on Science, Technology, Engineering and Mathematics (STEM) education is in its infancy in South African high schools. However, studies have shown that mobile learning (m-learning) can be used to mitigate the challenges of STEM education. Despite, the benefits that mobile learning can bring to rural STEM learners, its full potential has not been realized because, the adoption of mobile learning depends on users' acceptance. Prior studies focused on teachers' and learners' acceptance of mobile learning. However, little is known about the parents' acceptance of m-learning, especially in rural areas. This study explores the acceptance of m-learning by parents of rural high school STEM learners. The study proposes the parents' acceptance of m-learning model, which extends the technology acceptance model by introducing perceived social influence and perceived resources. Stratified random sampling was used to select 200 parents to participant in the survey. Partial least squares (PLS) structural equation modelling was used to analyse data from 129 valid questionnaires. The proposed model explained 41% of the variance in parents' acceptance of mobile learning. Attitude towards the use was found to be the best predictor and only factor that have direct effect on behavioural intention to use mobile learning. However, all other factors have an indirect influence on behavioural intention. The findings revealed that for mobile learning to be successfully implemented in rural areas, resources need to be provided.

Keywords: Technology Acceptance Model, Perceived Social Influence, Perceived Resources, STEM, Perceived Usefulness, Perceived Ease of Use.

1. Introduction

The integration of Science, Technology, Engineering and Mathematics (STEM) education is a growing area in both developed and developing countries [1]. Despite, STEM's fast growth, there is lack of a universally accepted definition of STEM education [2]. In the study [3], STEM education was defined as "…fostering sustained engagement with the STEM disciplines where students can become competent contributors and critical participants in a range of STEM-related activities." What can be drawn from this definition is that STEM education aims at shifting teaching practices from teacher centred into learner centred and problem-based learning.

As STEM education is in its infancy in South African high schools, it is faced with many challenges resulting in learners' poor performance at matriculation level [4, 8], especially in rural areas. Makgato [6] attributed this poor performance in STEM related subjects in rural areas to lack of learning materials, science laboratory and equipment to promote effective teaching and learning. Lack of parental involvement in their children's education also contributes learners' poor performance in STEM related subjects [5]. All the challenges that rural high school STEM learners face lead to demotivation when learning STEM related subjects [4]. Based on these studies [4, 5], one can conclude that there is no effective STEM teaching and learning in rural high schools.

Studies have shown that m-learning can be used to mitigate the challenges of STEM education [7-9]. M-learning enables the use of visualized science experiments. This can positively influence learners' knowledge of science, which can enable them to give complete descriptions of scientific concepts [9]. Furthermore, m-learning makes studying material available to learners anytime anywhere [7]. One can conclude that even though there are challenges in rural high schools, learners can still benefit from m-learning as they have access to learning materials and to visualise experiments using their mobile devices [7,9]. According to Kong [8], m-learning improves parents' involvement in their children's learning, which in turn improve learners' motivation and performance in STEM related subjects.

However, despite the positive effects m-learning can bring to rural STEM learners and the ubiquity of mobile devices, its adoption into classroom is far below the expected rate [10]. Davis [11] stated that the successful adoption of any information system contingent on user's acceptance. As a consequence of Davis' [11] assessment, it could be argued that successful implementation of m-learning in high schools of developing countries requires investigation all stakeholders' attitudes. A plethora of studies have been conducted to identify factors that affect the acceptance of mobile learning [12 -15]. However, a key issue is whether academics have adopted an adequately broad approach when investigating the attitudes of the main players in a high school instructional setting [16].

Most of these m-learning acceptance studies have concentrated on teachers [14,17] and learners [13, 17]. Little is known about the parents' attitude towards m-learning, especially in rural areas of developing countries. Teacher and learner preferences aside, parents have the last decision on whether to use m-learning. Parents' roles in m-learning includes financial support, encouragement, purchasing of the mobile device and data, monitoring that the devices are used in a meaningful way that enhance learning [8]. Despite parents playing an important role in the adoption of m-learning, their attitude towards mobile learning has not be given the attention it deserves [19].

Ford [18] stressed the need to carry out studies on the acceptance of mobile learning in the South African context and not to blindly follow examples in developed countries. Based on the argument thus far, the current research sought to examine the perceptions of parents of rural high school STEM learners towards m-learning.

Identifying and understanding these factors is important for the successful implementation of m-learning. Hence, this study used the technology acceptance model (TAM) to investigate the factors that predict rural high school STEM learners' parents' attitudes towards m-learning. Specifically, the study seeks to answers the following research questions:

RQ 1: What is the effect of parents' perceived usefulness, perceived ease of use, attitude towards the use, perceived resources, and perceived social influence on their behavioural intention to use m-learning?

RQ2: What is the relative importance of each of these factors in explaining parents' behavioural intention to use m-learning?

The findings of this study may provide more insight on m-learning acceptance in developing counties and help policy makers and all other stakeholders in education on how to successfully implement m-learning in rural areas.

2 Literature review and model development.

2.1 Literature review

Traditionally, the integration of m-learning has considered home environment as the basis for extending formal learning beyond the wall of the classroom [16]. However, there is a big difference between what teachers hoped for and what mobile devices are actually being used for at home. At home mobile device are mostly used for communication and playing games [39].

The most effective way of integrating m-learning into schools, is through involving parents' [8]. Parents' belief about m-learning influence their children's use [19]. Studies have shown that parents have contradictory attitudes towards the integration of mobile learning in children's education [16,19,39]. In a study carried out by Genc on the perception of parents towards mobile learning, the results show that about 46.88 % of parents were having negative perceptions, while 26.88 % were neutral while 26.56 % were having positive perceptions towards mobile learning [39]. Genc's results were congruent to Bourgonjon et al's findings, who stated that some parents expressed negative perception towards the use of mobile digital games-based learning [16]. In both studies [16,39], parents who had positive perceptions towards the integrating technology cited the usefulness of it in their children's education. However, parents were concerned about healthy and social issues associated with over exposure to technology [16].

A plethora of studies have shown that parents' PEOU has a positive effect on their ATT and PU [10, 15,17, 19, 35]. However, there is some inconsistence when it comes to the relationship between parents' PEOU and their BI to allow their children use m-learning. Studies [10] and [15] found that PEOU does not necessarily have a direct effect on BI. On the contrary, Alshmrany et al [17] reported that PEOU has a positive direct effect on BI.

Tsuei [19] studied the effect of parents' PSI on their PU and PEOU. The results showed that parent–teacher communication positively influenced both PU and PEOU. However, the communication between children and their parents only influenced parents' PU but not PEOU [19]. These results show that social influence plays an important role in parents' acceptance information and communication technology

(ICT) learning. Tsuei [19] highlighted the need to build partnerships between schools and parents for the successful integration of ICT learning.

2.1 Technology acceptance model (TAM) variables

TAM and the Unified Technology of Acceptance and Use Theory (UTAUT) are the commonly used models to study factors that affect the acceptance m-learning. In this study, TAM was selected because it is considered to be robust and it is mostly used model for the study of adoption of technology in educational contexts [23,24].

TAM expounded upon the ideas of the Theory of Reasoned Action [20]. Perceived usefulness and perceived ease of use are the two pillars of TAM. These two pillars predict users' attitude toward the use, which, in turn affect behavioural intention to use an information system [11]. Venkatesh [21] suggested that more variable that are context related can be added to TAM to improve its explanatory power of the acceptance of the technology in question as further explained [13].

Behavioral intention to use (BI)

BI was defined by Fang [25] as," … the cognitive representation of a person's readiness to perform a given behavior", and it is considered to be the best antecedent of behavior." Thus, TAM assumes that parents' adoption is determined by their BI to use m-learning [16].

Attitude towards the use (ATT)

Attitude toward a behavior is defined as, "… the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior studied" [26]. That is beliefs and attitudes play an important role in rejecting or accepting m-learning [28]. Parents' attitudes towards m-learning positively affect their behavioral intention to use [19]. This finding is congruent to the finding of Davis [11] and Dutota et al [26]. Therefore, the hypothesis:

H1: Attitude toward use has a positive effect on behavioral intention.

Perceive usefulness (PU)

In m-learning context, PU is explained as a person's perception that using m-learning will improve his or her teaching and learning [27]. One of the main factors behind parents' adoption of m-learning is the perception that m-learning is going to improve the performance of their children [16, 19]. Bourgonjon [16] studied the factors that makes parents accept digital game-based learning and found that learning opportunities was the single best predictor of parents' preference for video games. If parents perceive advantages in using m-learning, their attitude toward use of these technologies will be more positive. Therefore, the hypothesis:

H2: Perceived Usefulness has a positive effect on perceived attitude towards the use.

H3: Perceived Usefulness has a positive effect on affects behavioral intention to use.

Perceived ease of use (PEOU)

In m-learning context, PEOU can be defined as the extent to which users believe that adopting m-learning would be free from effort. When parents perceive that their children can use m-learning for learning STEM related with minimum effort, they will have a positive attitude towards it, will realise its utility and adopt it. Therefore, the hypothesis:

H4: Perceived ease of use has a positive effect on perceived usefulness.

H5: Perceived ease of use has a positive effect on behavioural intention to use.

H6: Perceived ease of use has a positive effect on attitude to use.

Perceived Resources (PR)

PR is defined as "… the extent to which an individual believes that he or she has the personal and organizational resources needed to use an information system" [30]. Perceived resources was found to have a positive effect on PU, PEOU and ATT [31-33]. In the studies [31-33], researchers investigated the effects of the availability of resources on teachers' acceptance of ICT into the classroom. They found that lack of laptops, computer technical and support from peers negatively affected the integration of ICT into the classroom. Mboweni [34] found that most of rural parents rely on social grants and have financial problems. M-learning requires money for purchasing of devices and data. Basing on the results of Lim [31] and Mboweni [34], one can learn that rural parents' perceived resources will affect their PU and PEOU towards the use of m-learning. Therefore, the hypothesis:

H7: Perceived resources has a positive effect on perceived usefulness

H8: Perceived resources has a positive effect on perceived ease of use.

Perceived social influence (PSI)

PSI is similar to theory of reasoned action's subjective norm [20], which was defined as "… a person's perception that most people who are important to him think he should or should not perform the behavior in question". In this study, PSI is when parents of high school STEM learners consider the view of those who are important to them whether they should or should not allow their child to use m- learning. Parents of STEM learners in rural areas are influenced by messages about m-learning. This was suggested by Venkatesh et al [21] who stated that people internalize the beliefs of other people and make them part of their own belief system. If parents think that their community, children, and teachers are expecting them to accept the use of m-learning, they will have a positive attitudes attitude m-learning. Therefore, the hypothesis:

H9: Perceived social influence has a positive effect on perceived usefulness

H10: Perceived social influence has a positive effect on attitude towards the use.

Based on the theoretical underpinning, a hypothetical model is in Figure 1.

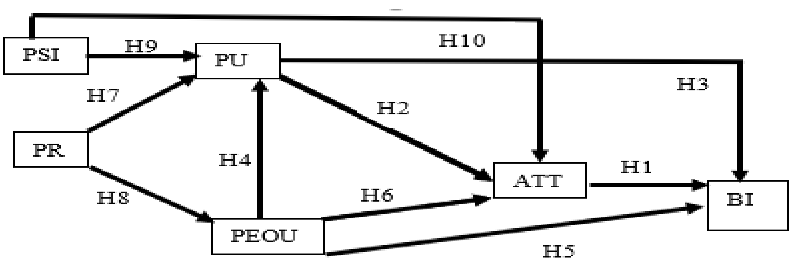

Figure 1: The parents' acceptance of mobile learning model

3 Methods

3.1 Research Design

The research followed a quantitative approach, where survey demographic and opinion-related data was collected from parents using a questionnaire. Firstly, the data from parents were explored using descriptive statistics. Secondly, partial least squares – structural equation model (PLS-SEM) was used to test the hypothesized model.

3.2 Participants

The study adopted stratified sampling to collect data [35]. All high schools in rural areas in one of the districts in KwaZulu Natal Province were grouped using their quintiles. To ensure that homogenous elements forms a stratum, schools in the same quintile were grouped together. Three strata were formed. Simple random sampling was then used to select four schools in each stratum. Sample random sampling was also used to select 200 grade 12 STEM learners from the selected schools. The selected learners were given questionnaires to give to their parents and 129 (65%) valid questionnaires were collected. Using Chin's [36] recommendation of 10 times larger than the number of items of the construct with most items, the sample size exceeds the recommended 50.

3.3 Measures

Firstly, the parents filled in questions about demographical information. Secondly, respondents answered the main part of the questionnaire, which comprised of scales measuring the constructs of the model. The questionnaire was adopted from previous studies [19, 33] and modified to suit the needs of the current study. The measurement instrument consists of six constructs making a total of 25 items. The questionnaire was developed and translated into IsiZulu and distributed both in English and IsiZulu. The respondents were asked to choose the language they are comfortable with. All items were measured on a 7-point Likert-type scale with 1 corresponding to "strongly disagree" and 7 to "strongly agree."

3.4 Analysis technique

Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to analyse data making use of the software SmartPLS 3. One of the functions of PLS-SEM is the prediction of the target variable [10] in this case rural parents whose children are pursing STEM's behavioral intention to allow their children to use m-learning. PLS-SEM was also used to assess the predictive power of antecedent variables. The study followed Chin's [36] two-stage approach of model analysis. First, the reliability and validity of different model variables were assessed to confirm the quality of the outer model. In the second step, the relationships within the structural model were assessed by testing the significance of the relationships, explained variance of the endogenous variables and predictive power of different variables [10].

4 Data analysis results

4.1 Measurement model assessment

The outer model describes the association between items and the latent variables. Convergent validity and discriminant validity of the outer model need to be assessed [37], in order to ascertain the goodness of fit of the out model. Convergent validity assesses the degree to which there is a high correlation between the latent variable which are theoretically identical, while discriminant validity assesses the degree to which a construct differs from other constructs [37].

The results (see Figure 2) show that almost all reflective indicators have loadings higher than 0.7 [37] except ATT1 (0.692), PR4 (0.612) and PU4 (0.671). The items were returned due to the exploratory nature of the study and removing them did not result in an increase on the composite reliability [37]. The results confirm item reliability. The results (Appendix 4) also confirm convergent validity as well, with Cronbach's alpha (α) greater than 0.7, composite reliability (CR) above 0.6 and average explained extracted (AVE) values greater than 0.5 [37].

Discriminant validity

Heterotrait-monotrait ratio of correlations (HTMT) and Fornell-Larcker criterion were used to assess discriminant validity [37]. Results (appendix 1) show that all the root of AVE is higher than inter-construct correlations and all the HTMT values are under 0.85 [37]. The results confirm discriminant validity.

Overall, the indicator reliability, internal consistence reliability, convergent validity and discriminant validity tests conducted on the measurement model are satisfactory.

4.2 Structural model assessment

After ascertaining the suitability of the outer model, the inner model was examined, and the hypothesis was tested. Before assessing the inner model, the variance inflation factor (VIF) was used to assess collinearity issues. All the VIF values were less than 4 [39], indicating that there are no collinearity issues. Results in (appendix 2) and Figure 2 summarize the inner model and the hypothesis testing results.

Figure 2 shows the R^2 of the model. The model explains 24% of PU 19% of PEOU, 43% ATT and 41% of the variance of rural parents' BI for their children to use mobile learning. The variance explained in rural parents' ATT and BI is considered moderate, while, variance explained in PU and PEOU is considered small [36]. The results of Figure. 2 also shows the standardized path coefficients. The results show that all model's antecedents predict rural parents' behavioral intention to allow their children to use mobile learning for learning STEM. Results (Appendix 1) show the results of bootstrapping procedure. The results show that all the hypotheses were supported except H3 and H5. Additionally, the results in (appendix 1) show the effect size of these relations. Two relations (ATT->BI and PEOU->ATT) have large effect size, PR-> PEOU has a medium effect size while the last five (PEOU->PU, PR->PU, PSI->ATT, PSI->PU and PU->ATT) have small effect size. The Q^2 values ranges from 0.16 to 0.23, indicting a medium predictive relevance [37].

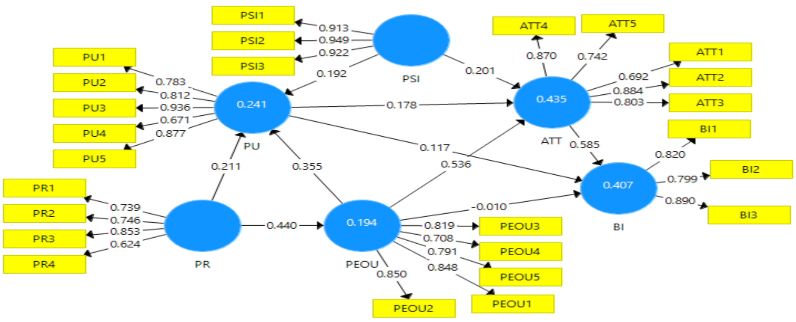

Figure.2. Structural equation model analysis

To answer research question 2, the observation of total effects (appendix 3) was used. The results show that the best predictors of parents' BI to allow their children to use mobile learning to STEM related subjects are ATT, PEOU and PR.

5 Discussions

RQ1: This study sought to examine the effects of PU, PEOU, ATT, PSI and PR on the behavioral intention to allow children to use mobile learning for rural parents. The results show that the model was appropriate for determining the rural parents' acceptance of mobile learning as it explains 41% of variance in BI. It was found that all the antecedents predict behavioural intention to use m-learning. However, only parents' ATT has a direct effect on BI. It would be reasonable to infer that when rural parents have positive feelings towards the use of m-learning, these positive feelings will reinforce their intention to allow their children to use m-learning to learn STEM related subjects. Parents' ATT mediates the effect of their' PU, PSI, PR and PEOU on their BI.

The results show some notable difference from prior adoption studies [10,11,13]. In contrary to previous finding, PU has an insignificant effect on rural parents' BI [13,19]. The results show that rural high school STEM learner's parents are not acquainted with the usefulness of mobile devices in the classroom. However, the results also confirm the finding of [19], who found that PU indirectly influences users' BI by the mediation of ATT. This might mean that even though rural parents have limited knowledge about the benefits that m-learning brings into STEM learning, that little knowledge they possess positively affects their attitudes towards the use of m-learning for STEM learning.

In contrary to the findings of Davis [11], the current study found that PEOU predicts ATT, better than PU. This shows that rural parents consider the effort needed to learn to use m-learning more important when adopting it than its utility. The finding might be due to parents belonging to the "digital immigrants" generation which struggle to use mobile devices to carry out specific tasks. The results also show that parents are not indifferent to what other people (teachers, society, and children) think about m-learning, as their ATT towards m-learning was influenced by their PSI better than their PU. These results are line with the findings of Tsuei [19], who found that teacher-parent and children-parents communication influenced parents' technology acceptance. PSI also positively affect PU and BI by the mediating of ATT. The results suggest that rural parents value what people important to them say about the use of m-learning for STEM learning. Therefore, it is important for teachers and learners to provide rural parents with awareness of the potential of m-learning for STEM related subjects.

Regarding PR, the results show that it positively affects both PU and PEOU. The results also show that PR has an indirect effect on BI through PEOU and ATT. This finding was not surprising due to the rural environment in which the study was carried. Most of the families in the rural areas are living in poverty and depend on social grants as their source of income [34]. It is also interesting to note that PR has indirect effects on ATT and PU by the mediating effect of PEOU. The results suggest that for rural parents, the availability of resources affects the usefulness and ease of use, which in turn affects parents' attitudes towards m-learning. The conclusion that can be drawn from this result is that, for a successful implementation of m-learning for STEM learning in rural areas, resources need to be provided.

Based on the current findings, Li et al [13] and Nikou et al [14] who studied learners' and teachers' acceptance of m-learning, the following suggestions can be made to mobile developers and instructional designers and Department of Basic Education (DBE). Mobile developers should make m-learning platforms user-friendly and contain as much learning material and assessments as possible. This is because rural parents, teachers and learners consider utility and ease of use to be important when adopting m-learning. The DBE should provide resources needed for mobile learning. The researchers suggest that the DBE should supply rural STEM learners with tablets. Furthermore, the DBE should use offline portals to support m-learning in rural areas, make some partnerships with cellular network service providers to allow some educational platforms and websites to be accessed freely, this will remove the burden of buying data from rural parents.

RQ2: The ordinal strength of the predictors of rural parents' BI to use mobile learning is as follows: ATT ($\beta = 0.629$, $p < 0.01$), PEOU ($\beta = 0.374$, $p < 0.01$), PR ($\beta = 0.189$, $p < 0.01$), PSI ($\beta = 0.148$, $p < 0.01$) and lastly PU ($\beta = 0.113$, $p < 0.05$).

One limitation in the current study is that it focuses on parents of STEM learners. Therefore, generalization of the findings of this study to all high school and primary parents in rural areas should be done with caution. Future studies should study perceived resources by clearly differentiating the different resources needed to support m-learning. It would be interesting to study perceived social influence to clearly determine the actual group (teachers, children, or society) that affect rural parents' attitudes towards m-learning.

6 Conclusion

Based on the results of this study, contrary to the findings of Davis [11], only parents' attitudes towards m-learning have a direct effect on rural parents' behavioural intention to allow their STEM learners to us m-learning. Additionally, the results support the suggestion by Venkatesh et al [22], who proposed that more variables that are context related can be added to TAM to study the acceptance of an information system. This study perceived social influence and perceived resources were added to TAM. The results showed that perceived social influence and perceived resources had a positive indirect influence effect on their behavioural intention to use mobile learning. The results also show that all the variables in the model predict behavioural intention to use m-learning. The predicting power of these variables is as follows: ATT, PEOU, PR, PSI and PU. The lessons that can be drawn from the study are that rural parents' attitudes towards m-learning and the perceived ease of use the most important factors that they consider when accepting m-learning. This might mean that parents expect their children to be trained on how to use m-learning before its implementation.

Furthermore, infrastructure, mobile devices and data need to be made available for mobile learning to be successfully adopted in rural areas.

7 Appendix

Appendix 1 Discriminant validity analysis.

	Fornell-Larcker criterion						HTMT					
	ATT	BI	PEOU	PR	PSI	PU	ATT	BI	PEOU	PR	PSI	PU
ATT	**0.802**											
BI	0.630	**0.837**					0.748					
PEOU	0.600	0.392	**0.805**				0.675	0.440				
PR	0.243	0.160	0.439	**0.744**			0.288	0.192	0.527			
PSI	0.184	0.187	0.068	0.288	**0.928**		0.204	0.208	0.084	0.365		
PU	0.433	0.366	0.435	0.316	0.106	**0.821**	0.480	0.401	0.476	0.367	0.118	

Appendix 2: Path coefficient

Hypothesis	Relation	Standard Beta	Confidence interval		f^2	P Values	Result
H1	ATT -> BI	0.585**	0.406-	0.710	0.349	0.000	Supported
H6	PEOU -> ATT	0.536**	0.356-	0.688	0.405	0.000	Supported
H5	PEOU -> BI	0,01	-0,171-	0.176	0.000	0.922	Not Supported
H4	PEOU -> PU	0.355**	0.199-	0.502	0.133	0.000	Supported
H8	PR -> PEOU	0.440**	0.294-	0.553	0.240	0.000	Supported
H7	PR -> PU	0.211*	0.055-	0.371	0.043	0.033	Supported
H10	PSI -> ATT	0.201**	0.073-	0.314	0.070	0.006	Supported
H9	PSI -> PU	0.192**	0.078-	0.264	0.044	0.001	Supported
H2	PU -> ATT	0.178**	0.037-	0.313	0.045	0.034	Supported
H3	PU -> BI	0.117	-0,077-	0.265	0.018	0.269	Not Supported

Appendix 3: Total effects

Relation	Standard Beta	Standard Error	T-Statistics	Confidence interval
ATT -> BI	0.629	0.054	11.610**	0.523 -0.705
PEOU -> ATT	0.595	0.094	6.315**	0.431 -0.728
PEOU -> BI	0.374	0.075	4.977**	0.246 -0.492
PEOU -> PU	0.355	0.097	3.649**	0.196 -0.508
PR -> ATT	0.301	0.059	5.097**	0.190 -0.384
PR -> BI	0.189	0.046	4.098**	0.109 -0.254
PR -> PEOU	0.440	0.086	5.126**	0.274 -0.556
PR -> PU	0.371	0.090	4.130**	0.217 -0.505
PSI -> ATT	0.235	0.069	3.401**	0.132 -0.354
PSI -> BI	0.148	0.046	3.204**	0.079 -0.226
PSI -> PU	0.192	0.059	3.275**	0.086 -0.279
PU -> ATT	0.180	0.087	2.081*	0.044 -0.323
PU -> BI	0.113	0.058	1.966*	0.027 -0.218

Significant at p** = <0.01, p* <0.05.

Appendix 4: Measurement model.

Construct	PR	PU	PEOU	PSI	ATT	BI
Cronbach's alpha (α)	0.737	0.877	0.865	0.920	0.858	0.790
CR	0.831	0.911	0.902	0.949	0.899	0.875
AVE	0.554	0.673	0.648	0.861	0.642	0.701

8 References

1. El-Deghaidy, H., & Mansour, N. (2015). Science Teachers' Perceptions of STEM Education: Possibilities and Challenges. International Journal of Learning and Teaching, 1(1), 51-54.
2. English, L. D. (2015). STEM: Challenges and opportunities for mathematics education. Paper presented at the Proceedings of the 39th Conference of the International Group for the Psychology of Mathematics Education, Hobart, Tas.
3. Burke, L., Francis, K., & Shanahan, M. (2014). A horizon of possibilities: A definition of STEM education. Paper presented at the STEM 2014 Conference, Vancouver
4. Chan, Y. L., & Norlizah, C. H. (2017). Students' Motivation towards Science Learning and Students' Science Achievement. International Journal of Academic Research in Progressive Education and Development, 6(4), 174-189.
5. Modisaotsile, B. M. (2012). The Failing Standard of Basic Education in South Africa AISA POLICY brief: Africa Institute of South Africa.
6. Makgato, M. (2007). Factors associated with poor performance of learners in mathematics and physical science in secondary schools in Soshanguve, South Africa. Africa Education Review, 4(1), 89-103.
7. Criollo,C. S., Luján-Mora, S., & Jaramillo-Alcázar, S. (2018). Advantages and Disadvantages of M-Learning in Current Education. Paper presented at the 2018 IEEE World Engineering Education Conference (EDUNINE).
8. Kong, S. C. (2018). Parents' perceptions of e-learning in school education: Implications for the partnership between schools and parents. Technology Pedagogy and Education, 27(1), 15–31.
9. Pinker, S. (1997). How the Mind Works. New York: W. W. Nortan.
10. Sánchez-Prietoa, J. C., Hernández-Garcíab, Á., García-Peñalvoa, F. J., Chaparro-Peláezb, J., & Olmos-Migueláñeza, S. (2019). Break the walls! Second-Order barriers and the acceptance of mLearning by first-year pre-service teachers. Computers in Human Behavior, 95(2019), 158–167.
11. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319-340.
12. Estrieganaa, R., Medina-Merodiob, J.-A., & Barchino, R. (2019). Student acceptance of virtual laboratory and practical work: An extension of the technology acceptance model. Computers & Education, 135(2019), 1-14.
13. Li, R., Meng, Z., Tian, M., Zhang, Z., Ni, C., & Xiao, W. (2019). Examining EFL learners' individual antecedents on the adoption of automated writing evaluation in China. Computer Assisted Language Learning.
14. Nikou, S. A., & Economides, A. A. (2019). Factors that influence behavioral intention to use mobile-based assessment: A STEM teachers' perspective. British Journal of Educational Technology, 50(2), 587–600.
15. Saroia, A. I., & Gao, S. (2018). Investigating university students' intention to use mobile learning management system. Innovations in Education and Teaching International.
16. Bourgonjon, J., Valcke, M., Soetaert, R., Wever, B. d., & Schellens, T. (2011). Parental acceptance of digital game-based learning. Computers & Education, 57(2011), 1434-1444.
17. Alshmrany, S., & Wilkinson, B. (2017). Factors Influencing the Adoption of ICT by Teachers in Primary Schools in Saudi Arabia: Teachers' Perspectives of the Integration of ICT in Primary Education. IJACSA, 8(12), 143-156.

18. Ford, M., & Botha, A. (2010). A Pragmatic Framework for Integrating ICT into Education in South Africa. Paper presented at the IST-Africa 2010 Conference Proceedings.
19. Tsuei, M., & Hsu, Y.Y. (2019). Parents' Acceptance of Participation in the Integration of Technology into Children's Instruction. Asia-Pacific Education Research
20. Fishbein, M., & Ajzen, J. (1975). Beliefs, Attitudes, Intention, and Behavior: An Introduction of Theory and Research Reading, MA.: Addison Wesley Publishing.
21. Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: four longitudinal field studies. Management Science, 46(2), 186-04.
22. Venkatesh, V., Morris, M. G., Davis, G., B, & Davis, F. D. (2003). User Acceptance of Information Technology: Towards a Unified View. MIS Quarterly, 27(3), 425 - 478.
23. Park, S. Y. (2009). An analysis of the technology acceptance model in understanding university students' behavioral intention to use e-learning. Educational Technology & Society, 12(3), 150-162.
24. Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. Computers & Education, 52(5), 302-312.
25. Fang, C. S. O. Y., Kayad, F., & Misieng, J. (2019). Malaysian Undergraduates' Behavioural Intention to Use LMS for Online English Learning: An Extended Self-Directed Learning Technology Acceptance Model. Journal of ELT Research, 4(1), 8.
26. Dutota, V., Bhatiasevib, V., & Bellallahom, N. (2019). Applying the technology acceptance model in a three-countries study of smartwatch adoption. Journal of High Technology Management Research, 30(2019), 1–14.
27. Cheng, E. W. L. (2019). Choosing between the theory of planned behavior (TPB) and the technology acceptance model (TAM). Educational Technology Research and Development, 67(1), 21–37.
28. Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. Decision Sciences, 39(2), 273–315.
29. Yorganci, S. (2017). Investigating Students' Self-Efficacy and Attitudes Towards the Use of Mobile Learning. Journal of Education and Practice, 8(6), 181-185.
30. Mathieson, K., Peacock, E., & Chin, W. W. (2001). Extending the technology acceptance model: the influence of perceived user resources. ACM SIGMIS Database, 32(3), 86-112.
31. Lim, C. P., & Khine, M. S. (2006). Managing teachers' barriers to ICT integration in Singapore schools. Journal of Technol-ogy and Teacher Education, 14, 97–125.
32. Teo, T., Lee, C. B., & Chai, C. S. (2007). Understanding pre-service teachers' computer attitudes: applying and extending the technology acceptance model. Journal of Computer Assisted learning, 126-143.
33. Sivo, S. A., Ku, C.-H., & Acharya, P. (2018). Understanding how university student perceptions of resources affect technology acceptance in online learning courses. Australasian Journal of Educational Technology, 34(4), 72-91
34. Mboweni, L. (2014). Challenges and factors contributing to learner absenteeism in selected primary schools in Acornhoek. (Master of Education), Unisa.
35. Creswell, J. W. (2014). Research design: qualitative, quantitative, and mixed methods approaches (4th ed.). Thousand Oaks, USA:SAGE Publications, Inc.
36. Chin, W. W. (Ed.). (1998). The Partial Least Squares approach for structural equation modelling. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

37. Hair, J. J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2016). A primer on partial least squares structural equation modeling (PLS-SEM): Sage Publications.
38. Salloum, S. A., Al-Emran, M., Shaalan, K., & Tarhini, A. (2019). Factors affecting the E-learning acceptance: A case study from UAE. Education and Information Technologies,24,509–530.
39. Genc, Z. (2014). Parents' perceptions about the mobile technology use of preschool aged children. Procedia - Social and Behavioral Sciences 146 (2014) 55 – 60.