MOBILE LEARNING TECHNOLOGY IN HIGHER EDUCATION INSTITUTIONS TO SUPPORT DIGITAL TRANSFORMATION

by

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DECLARATION

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I hereby affirm that the thesis I am submitting for the Master of Science in Computing degree at the University of South Africa is entirely original, with full citations to all sources utilised or mentioned. I have also submitted my paper to Turnitin for verification of any similarities to other papers and met the minimum score as required by Unisa.

Date: January 2026

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DEDICATION

I dedicate this paper to the Lord Jesus Christ, individuals and institutions below:

My wife: Makhavhu Matodzi Millicent

My children: Makhavhu Dziphathutshedzo and Makhavhu Mulweli

My father and my siblings, in honour of our late mother, Makhavhu Lutanani Alvinah

My spiritual home and family of The Life of God Christian Church

My Supervisor, Dr M Phahlane,

Thank you for your continued support and encouragement in this academic journey.

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I would like to extend my deepest gratitude to all the individuals who made it possible for me to accomplish this dream. It was not an easy journey; however, with all the assistance, effort, time and sacrifice made for this study to be a success, I am deeply humbled to offer my sincere gratitude to all who made it possible:

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- To my brother Phethani Mashamba – like I have always said, “I Wanna Be The First”. This kingdom belongs to those who want it most. It is our Time.

1. publications from this researchA multi-theoretical thematic synthesis expounding challenges influencing students' attitudes and intentions towards mobile Learning in Higher Education.

   (Article under Editor's Review).

ABSTRACT

Introduction

The global utilisation of mobile learning technologies has significantly impacted the higher education sector, influencing institutional transformation. Yet, in South Africa, institutions such as TVET colleges face significant challenges related to accessibility, equity, infrastructure, financial, and relevant digital skills that delay the adoption and use of mobile learning in academic settings.

Objective: To examine the influence and use of mobile learning technologies within supporting higher education institutions as a digital transformation strategy, using the Diffusion of Innovation theory to underpin the study.

Methods: A positivist, quantitative, deductive approach was employed through a survey of 242 participants at Vhembe TVET College. Data analysis was conducted, incorporating descriptive statistics, reliability testing, EFA, path analysis, correlation, multiple regression, and mediation analysis, to evaluate the influence of DOI components and attitude on usage intention.

Results: The findings indicated that attitude is the strongest predictor of usage intention, aligning with both analytical approaches. Notably, two tested hypotheses (H3 and H6), related to the relative advantage and compatibility of the technology, lacked support. Moreover, opportunities and challenges were identified, revealing that students have significant mobile ownership, although they often encounter ongoing connectivity and economic challenges that hinder sustained use of mobile learning.

Conclusion: These results demonstrate that student use of mobile learning technologies in academic settings extends beyond being an educational technology but a crucial facilitator of digital transformation.

Contribution: This study has made a significant contribution to the field of information systems and mobile learning in higher education, demonstrating an existing relationship initiated by the implementation of mobile learning as part of digital transformation within the South African context and learning environment.

Keywords: adoption, artificial intelligence, digital transformation, education, innovation, mobile learning, students, technology.

LIST OF ABBREVIATIONS

Abbreviation	Definition
AI	Artificial Intelligence
AGFI	Adjusted goodness of fit index
CFI	Comparative Fit Index
CLT	Cognitive Load Theory
DOI	Diffusion of Innovation
EFA	Exploratory Factor Analysis
GFI	Goodness of Fit Index
HE	Higher Education
HEIs	Higher Education Institutions
HSRC	Human Sciences Research Council
KMO	Kaiser-Meyer-Olkin
NFI	Normative Fit Index
OB	Observation
IP	Innovation Perception
IS	Information Systems
PRISMA	Recommended Reporting Items For Systematic Reviews and Meta-Analysis
RB	Response in Behaviour
RMSEA	Root mean square error of approximation
SPSS	Statistical Package for the Social Sciences

SRMR	Standardised Root Mean Square Residual
TAM	Technology Acceptance Model
TTF	Task Technology Fit
TLI	Tucker–Lewis Index
UTAUT	Unified Theory of Acceptance and Use of Technology
VIF	Variance Inflation Factor

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CHAPTER 1 – INTRODUCTION AND BACKGROUND.

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1.1 INTRODUCTION TO THE FIELD OF STUDY

The role of digital transformation and information Systems in the learning process.

Modern technologies have played a significant role in enabling the advancement of innovations (Sari, Rahim, Sundari & Aulia, 2022) and digital transformation (Bucăţa, Popescu & Tileagă., 2022). The digital transformation of an institution is described as a cultural and psychological shift, the reduction of administrative processes, and the prioritisation of the user within

Information Systems (IS), all while improving the utilisation of information resources (Bucăţa et al., 2022). As such, IS is the foundation of transformation in the digital revolution in education and has been used to enhance students' learning and learning outcomes (Criollo-C, Guerrero-Arias, Jaramillo-Alcázar & Luján-Mora, 2021). This transformation is enabled by the introduction of a system or processes and has created significant opportunities to enhance normal classroom education through the provision of distance learning, benefiting the educational sector. This transformation has enabled Higher Education Institutions (HEIs) to transform how they do things (Alzaidi & Shehawy, 2022). For this reason, the global Higher Education (HE) sector has experienced significant growth due to the rising prevalence of IS to transform processes and meet the needs of students (Mhlanga, 2023; Lai, Saab & Admiraal, 2022). Society and the higher education community have recognised the importance of innovative technologies for HE, leading to initiatives aimed at promoting the incorporation and acceptance of IS (Ayanwale & Ndlovu, 2024). As a result, HEIs looking to transform academic processes and deliver content digitally often expose staff members, educators, and students to these IS innovations.

The role of mobile learning as a major approach to digital transformation in South Africa.

Amongst the several digital transformation approaches, Mobile learning is one of the most important digital technologies that enhances the way students learn. These insightful technologies incorporated within South Africa's HE system have presented significant possibilities for enhancing academic initiatives and achieving sustainable development goals (Opesemowo & Adekomaya, 2024). This shift to technology-based learning has been notably important due to the current demand for high-quality global education, which has necessitated rapid adaptations to online learning methods (Alshurideh, Al Kurdi, Salloum, Arpaci & Al-Emran, 2023). Mobile technology, including smartphones, has offered numerous aspects that improve mobile student learning, such as customised interfaces and instant availability of information, contextual awareness, speedy communication, and prospects for feedback (Alturki & Aldraiweesh, 2022). Moreover, these devices and wireless networking facilitated the widespread access to resources, cooperation, and customised feedback (Alfalah, 2023; Alturki & Aldraiweesh, 2022). Thus, the mobility and adaptability of these mobile computing devices enable students to contextualise education, engage with real-world challenges, and customise learning experiences.

Previous studies Lazaro & Duart (2023) and Alzaidi & Shehawy (2022) have highlighted the importance of implementing mobile learning to support HE digital transformation. A systematic review revealed that mobile learning facilitates customised, relevant, and engaging learning experiences (Lazaro & Duart, 2023). Consequently, by utilising mobile learning, HEIs were able to address students' needs while highlighting the importance of technology convenience and flexibility (Alzaidi & Shehawy, 2022). New digital innovations and technology adoption models have also highlighted the importance and growing acceptance of mobile learning in HE. This is supported by the Technology Acceptance Model (TAM) (Alturki & Aldraiweesh, 2022), the Unified Theory of Adoption and Use of Technology (UTAUT) (Alfalah, 2023; Alzaidi & Shehawy, 2022), Enterprise Content Management (ECM) (Alzaidi & Shehawy, 2022; Hameed & Sumari, 2024), and DeLone and McLean's Information System Success (ISS) model (Althunibat, Almaiah & Altarawneh, 2021; Lutfi, Saad, Almaiah, Alsaad, Al-Khasawneh, Alrawad, Alsyouf, & Al-Khasawneh, 2022), just to mention a few. Moreover, mobile learning enhanced with AI, which includes intelligent guidance and personalised content generation, has introduced an enhanced level of technology adaptability and sustainability (Arini, Hidayat, Winarti & Rosalina, 2022; Baba, El Faddouli & Cheimanoff, 2024; Moya & Camacho, 2024; Guo, Halim & Saad, 2025). These learning technologies should be seen as the future of effective and impactful education for students across all HE institutional departments and educational levels.

The transformative influence of mobile learning on HEIs' processes.

This study has emerged as an encouragement for institutional digital transformation that influences various processes or areas of interest, although it primarily examines the utilisation of mobile learning and its impact on students' learning processes. As a result, it has become a commonly used tool for educational and learning processes. Mobile learning promotes interactive classrooms, smooth integration of both online and traditional learning, and data-driven feedback, which has improved engagement and achievement (Goundar & Kumar, 2022; Sari et al., 2022). Mobile learning can impact the administrative and service delivery processes of HEIs, which are crucial in initiating learning. This agreed with Bucăţa et al. (2022), who indicated that institutions no longer operate in an ordinary manner, where tasks are performed manually through data entry in registers, printing reports or declarations on paper, receiving

approvals via handwritten signatures, and physically transferring documents within the approval or authorisation process.

Another aspect of mobile learning is its impact on institutional strategies and the sustainability of technology. This included the capability of mobile learning to address modern educational needs and objectives; the likelihood of users' acceptance of these technologies; the adaptability to potential changes; the capacity to be sustained in a specific state continuously, or to offer progress (Al-Rahmi, Al-Rahmi, Alturki, Aldraaiweesh, Almutairy & Al-Adwan, 2021). For example, mobile learning integration with AI bridges the geographical gap within the HEIs' processes, in turn enhancing the delivery or implementation of learning strategies. This was because AI had the ability to analyse extensive data and customise to specific student requirements, and transform the methods and locations of learning (Moya & Camacho, 2024).

The historical context of information systems as the foundation of digital transformation.

The origin.

The domain of IS originated in the 1960s, initially referred to as management information systems, and has since undergone continuous evolution (Hirschheim & Klein, 2012). The origination of these systems was a combination of management, computer science, and organisational science, initially concentrating on transaction processing and management information systems that facilitated decision-making within organisations (Britannica, 2024). These systems are based on the incorporation of hardware, digital applications, storage, communication systems, internet utilities, and various components of a business, organisation, government, education institution, or other entity's technological infrastructure, which constitutes the framework for big data structure and management (Berdik, Otoum, Schmidt, Porter & Jararweh, 2021).

The evolution.

In modern times, IS has transitioned into various sectors, including education, by shifting from just being a support technology to a strategic focus on digital transformation and redefining institutional operations. Consequently, institutions have progressively depended on integrating structures, operations, and strategies with technical departments to achieve numerous advantages, including enhancements in costs, performance, and the quality of products and services (Fischer, Imgrund, Janiesch & Winkelmann, 2020). In the HE context, the transition

involved integrating systems used for learning, mobile applications, data transmission networks, and artificial intelligence to facilitate a flexible, data-driven environment centered around student learning (Criollo-C et al., 2021; Haleem, Javaid, Qadri & Suman, 2022).

The current state.

Modern scholarly studies have provided a comprehensive analysis of the existing state of IS development in the HE sector, highlighting several key challenges, including mobile learning and AI, as essential elements of digital transformation. These studies indicated that mobile learning enhances accessibility, flexibility, and engagement, while facilitating personalised and self-directed learning (Arini et al., 2022; Baba et al., 2024; Lazaro & Duart, 2023; Sisouvong & Pasanchay, 2024). Moreover, AI-enhanced mobile learning was found to have the ability to provide personalised material, insightful feedback, and data analytics, although it presented challenges related to privacy, bias, and academic integrity for HEIs (Baba et al., 2024; Guo et al., 2025; Moya & Camacho, 2024). South Africa's TVET colleges are undergoing a substantial transformation as they adopt mobile learning to modernise education and meet the requirements of the Fourth and Fifth Industrial Revolutions (Denhere & Moloi, 2021).The adoption of the technology was stronger when users perceived risk and complexity were low; the relative advantage, compatibility, trialability, and observability of the technology were higher or positive (Acikgoz, Elwalda & De Oliveira, 2023; Amini & Javid, 2023; Arora et al., 2022; Ayanwale & Ndlovu, 2024; Fahad & Shahid, 2022; Menzli, Smirani, Boulahia & Hadjouni, 2022; Sim, Chen, Chai & Khan, 2023). On the other hand, users' attitudes were strong determinants of usage intentions (Alfalah, 2023; Al-Rahmi et al., 2021; Alturki & Aldraiweesh, 2022; Lutfi et al., 2022) later, facilitating the actual use of the technology.

The rise of modern technologies has also brought several challenges for HEIs related to accessibility, equity, and infrastructure. These significant challenges were notably high in developing countries, where infrastructure problems, data expenses, and digital literacy issues exist, even though device ownership does not necessarily equate to meaningful usage (Goundar & Kumar, 2022). For example, evidence from South African studies reflects these trends, highlighting persistent inequalities in accessibility, connectivity, and costs, as well as a lack of institutional preparedness, which influence both adoption and continued usage (Mabidi, 2024; Mateko, 2024; Shumba, Munkuli & Saruchera, 2025).

How this study fit in the IS field.

This study aligns well with the IS field, as a contextual contribution was evaluated in a South African HIE environment (Vhembe TVET college). This has enabled the study to identify sensitive and under-researched concepts in the context of developing countries, including infrastructure, accessibility, equity, and addressing the challenges related to connectivity, cost, and digital skills literacy, as noted in the literature (Frei-Landau, Muchnik-Rozanov & Avidov-Ungar, 2022; Mateko, Dowelani & Sinamano, 2025). The study is theoretically sound, as it adopts the DOI theory components, including relative advantage, compatibility, complexity, observability, and trialability (Frei-Landau et al., 2022), as well as perceived risk, and examines the overall effect on usage intention, mediated by attitudes. It enhances the IS literature by going beyond conventional models of technology adoption, such as TAM and UTAUT (Alfalah, 2023; Al-Rahmi et al., 2021; Alturki & Aldraiweesh, 2022), and incorporating innovation characteristics to monitor user intention from initial adoption to actual use. Practically, these study findings provide significant information for AI-enhanced mobile learning, including the reduction of risk, complexity, and costs, as well as the promotion of the technology's relative advantages, compatibility, accessibility, equity, and visibility. This allows institutions to manage sustainable digital transformation in academic environments (Al-Rahmi et al., 2021; Bucăţa et al., 2022; Lutfi et al., 2022). Thus, this study methodologically contextualises the causal relationship among the DOI components, perceived risk, attitude, and enhanced by demographic factors such as age, gender, and education level, and the overall influence on students' intention to use mobile learning technology.

1.2. DEFINITION OF KEY TERMS

This section provides an explanation of the critical terms used in this study

Adoption.

Adoption was described as the determination to fully utilise technology as the most suitable course of action (Sahin, 2006). According to Rogers (2003), the extent to which individuals had perceived a technology ultimately influenced its adoption. In HE, adoption was described as the degree to which students utilise, incorporate, and rely on mobile technology to improve learning and collaboration in academic settings (Alfalah, 2023; Al-Rahmi et al., 2021; Alturki & Aldraiweesh, 2022). From a DOI theoretical perspective, the adoption of technology is influenced by various components, including relative advantage, compatibility, complexity,

trialability, and observability (Abdalla, Bhat, Tiwari, Khan & Wedajo, 2024; Amini & Javid, 2023; Arora, Sharma & Singh, 2022; Fahad & Shahid, 2022). Thus, each of these components affects how students perceive the use of mobile learning in education. For example, these components could also be strengthened by other components, such as institutional support, attitudinal, perceived risk, perceived usefulness, satisfaction, and social determinants (Al-Mamary, 2022; Bayastura, Warsito, Mutiara & Nugraheni, 2022; Chatzopoulos, Kalogiannakis, Papadakis & Papoutsidakis, 2022; Menon & Shilpa, 2023). In this study, the concept of adoption is reflected through a complex process involving students' attitudinal, behavioural, and social factors, as well as the relationship with the technical aspects of the institution.

Artificial intelligence.

Artificial intelligence (AI) may be regarded as the capability of machinery or other non-human entities to perform activities such as the execution of tasks, solve problems, communicate, interact, and act in ways that are comparable to how natural humans perform (Gil De Zúñiga, Goyanes & Durotoye, 2024). Furthermore, the diverse perspectives on AI are consolidated around its designation as a scientific discipline dedicated to the exploration, conceptualisation, and practical application of intelligent devices or systems designed to replicate human cognitive abilities and augment human intelligence capabilities (Moya & Camacho, 2024). As such, it has been progressively utilised in education to facilitate customised learning, intelligent tutoring systems, automated feedback, and adaptive assessments, hence improving student learning results and decreasing administrative responsibilities for educators (Baba et al., 2024; Guo et al., 2025).

Digital transformation.

Digital transformation can be described as the implementation of digital innovation to improve productivity, expand end users' exposure, and promote effectiveness (Bucăţa et al., 2022). In HE settings, digital transformation involves more than just the utilisation of technology tools. It is concerned with the reorganisation of the integration of individuals, data, and processes to promote improved settings for students, educators, parents, and system leaders in the modern digital-centric landscape, while also anticipating upcoming innovations and problems (McCarthy, Maor, McConney & Cavanaugh, 2023).

Education.

The term education was understood to be comprised of all elements that contribute to an individual's development, persisting throughout one's lifetime (Adesemowo & Sotonade, 2022) . It served as an essential platform for exchanging knowledge on significant issues today (Haleem et al., 2022). In HE, it is viewed as a simultaneous process conducted in both formal and informal settings that empowers learners with the information, abilities, societal values, and competencies essential for the labour market. Today, the evolution of education has led to numerous technological innovations that have been perceived as the high point of traditional education in its existing formats (Mhlanga, 2023).

Innovation

Innovation is thus defined as at least something groundbreaking, or the process of attaining such a concept (DeJong & De Vries, 2025). In HE, the concept of innovation involved the implementation of mobile learning, artificial intelligence, and digital platforms as a way to improve learning methods, increase accessibility, and optimise institutional administration (Criollo-C et al., 2021). Thus, the future continuation and motivation to use the innovation relied on the necessary modifications to enhance implementation and desire (Frei-Landau et al., 2022).

Mobile learning.

This concept is thus referred to as the application of mobile handheld gadgets, like smartphones, iPads, and tablets, to facilitate educational experiences that are accessible at any location and time (Alturki & Aldraiweesh, 2022; Goundar & Kumar, 2022). In HE, these technological developments, intelligent applications, and methods are consistently employed to revolutionise the educational system, optimising the integration of technology within the sector (Qazi, Qazi, Naseer, Hasan, Hardaker & Bao, 2024). It is widely acknowledged as an instructional method that has enabled learners to pursue information acquisition and skill development through various means, regardless of geographical location and time constraints (Moya & Camacho, 2024; Sophonhiranrak, 2021). These applications are typically used for process improvement, communication, and enhancing flexibility in educational settings. Nevertheless, it has recently enhanced its ability to furnish appropriate feedback, personalised learning pathways, and

facilitate continuous learning through the integration of AI-driven mobile applications (Arini et al., 2022; Moya & Camacho, 2024). This means that the facilitation of widespread, customised, and flexible education can be achieved in HE by utilising mobile learning technologies, wireless networks, and digital information.

Students.

Students are designated individuals registered in an academic institution, such as a college or university, and participating in academic programmes (Collins, 2024). These individuals are represented by a mixed demographic group, varying by level of education, gender, age, cultural background, and socio-economic status, which usually influence the adoption and utilisation of mobile learning technology in HE. From a local perspective, understanding students' behaviours, attitudes, and digital preparedness was essential for formulating effective mobile learning approaches that encourage engagement, accessibility, and fairness (Ramchurn, Roodt & Mulaji, 2021; Shumba et al., 2025).

Technology.

Technology was described as a phenomenon resulting from the application of scientific knowledge to practical scenarios (Collins, 2024). In HE, information technology has emerged as a catalyst for spreading common information and has been a principal foundation for educational innovations (Haleem et al., 2022). It was significantly interconnected with social and cultural aspects, influencing the interactions between students and educators regarding information in the digital age (Bucăţa et al., 2022). These tools can include hardware instruments, software applications, and physical and wireless connectivity used to address students' learning problems, modify behaviours, and enhance HE efforts to deliver high-quality digital education.

1.3. CONTEXT OF THE STUDY

The HE system in South Africa (Universities and TVET colleges) is experiencing a significant transition towards digital transformation, influenced by the current demand to meet student expectations and competitiveness, as well as the global pressure to deliver quality education. For example, many South African HEIs, including the University of Johannesburg, the University of Pretoria, and the University of Cape Town, have not publicly declared the

transition but have shifted to technology-enhanced learning practices (Mhlanga & Moloi, 2020). The University of Johannesburg went even further by transforming into a university of technology. According to a report by the Human Sciences Research Council (HSRC), most South African TVET colleges are redefining their digital transformation strategies by incorporating comprehensive mobile learning initiatives and operational changes in the digital era. These strategies include enhancing digital infrastructure, upskilling educators, designing mobile interface curricula, and employing IS professionals to customise educational experiences (HSRC, 2023). Moreover, initiatives exemplified by the ETDP SETA and Letaba TVET College demonstrate that public TVETs are proactively implementing mobile and AI-driven solutions to improve educational processes (TVET College, 2025).

Although these HEIs have achieved significant progress in digital transformation, numerous institutions, particularly those historically disadvantaged, still struggle with infrastructure limitations, inconsistent technical capabilities, and digital inequalities (Mabidi, 2024). However, the COVID-19 epidemic highlighted and accelerated these inequities, compelling higher education institutions to swiftly implement remote and digital teaching methods, while exposing deficiencies in device accessibility, network infrastructure, and preparedness (Shumba et al., 2025). South Africa has demonstrated a mobile internet penetration rate of 78.8%; yet, the high price of technological products and services poses a significant challenge for end users (Mateko, 2024).

Like other developing countries, mobile learning presents both opportunities and challenges for students and TVET colleges in South Africa during the learning process. This was advantageous for both employed and unemployed students who learned at a slower pace and were able to interact with the course material at own convenience by viewing lecture recordings or organising study schedules accordingly (Mabidi, 2024). Despite the advantages, the swift implementation of online learning has revealed numerous obstacles, particularly in terms of infrastructure, student engagement, and the technological gap (Shumba et al., 2025). As a result, several HEIs have reconsidered strategies towards the provision of services, organisation of students, development of educational programs, and the creation of effective learning environments (Mabidi, 2024). These are practical issues faced by the majority of South African HEIs, including TVET colleges, in providing effective learning experiences for students, which continuously affect the mobile learning adoption, utilisation, and sustainability. Thus, mobile learning in South Africa is significant and important for HEIs, as it is at the centre of digital

transformation, strategy and policy development, academic activities, and students' access to education and learning.

1.4. BACKGROUND TO THE RESEARCH PROBLEM (IDENTIFIED GAPS)

The HE system in South Africa has undergone a quick and inconsistent change due to the emergence of digital learning methods. This shift was also quickened and notable during the emergence of the COVID-19 pandemic. Consequently, many HEIs quickly switched from traditional learning to online and mobile learning channels. Although mobile learning channels enable university students to access educational content via mobile devices, there is limited research on students' intentions to utilise them (Al-Rahmi, Al-Rahmi, Alturki, Aldraaiweesh, Almutairy & Al-Adwan, 2022). As a result, several research gaps have been identified, highlighting the importance of this study in the South African HEIs' academic environment.

Gap 1: lack of research on mobile learning long-term sustainability.

Post-COVID-19 epidemic, few studies in South Africa have examined how mobile learning can be implemented to support digital transformation and how the acceptance of mobile learning practices has influenced utilisation in learning since then (Mateko et al., 2025). Many of the reviewed studies conclude at the level of intention, with a limited focus on actual utilisation and long-term sustainability (Al-Rahmi et al., 2021; Lazaro & Duart, 2023). There is a need for additional research that examines the prediction of DOI components on user behaviour beyond the usage intention of the technology. This effort will assist HEIs in developing strategies that monitor user behavioural intention over time for effective and sustainable digital transformation practices.

Gap 2: AI Integration and ethical concerns.

Many international studies have illustrated the importance of AI-enhanced mobile learning in HE (Baba et al., 2024; Guo et al., 2025; Moya & Camacho, 2024). However, few studies in South Africa have examined the privacy, trust, security, and ethical aspects significant to HEIs' integration of AI in education. There is a need for a specific study that deals with the integration of AI aspects, such as privacy, trust, bias, fairness, and transparency, within South African HEIs, and these issues affect the adoption and use of AI-powered mobile learning in the academic environment.

Gap 3. Technology complexity and digital well-being.

Most of the global and local studies evaluated were based on behavioural and technology adoption models, with a specific focus on technology performance, usability, and student satisfaction. A few of these studies highlighted the significance of technology overuse, fatigue, and the mental load effect on continuous technology use. This calls for additional research that investigates the effect of technology complexity, users' attitude, and the relationship influence on mental load and student digital well-being.

Gap 4. Limited infrastructure and technology accessibility.

A future study is required to investigate the challenges and obstacles documented in mobile device-based learning, particularly those related to technical factors such as interface design and unreliable internet connectivity (Sophonhiranrak, 2021). Research in South African HEIs has revealed that accessibility to mobile devices, poor infrastructure, connectivity, and high data costs were long-standing challenges for many students, especially those from underprivileged educational backgrounds, making it difficult to participate and learn in real time (Mabidi, 2024; Mateko et al., 2025; Shumba et al., 2025). These long-standing and persistent challenges create digital inequality and hinder the continued adoption of mobile learning technology, preventing HEIs from benefiting from digital transformation initiatives.

Gap 5: Lack of studies in the TVET college context.

South African studies in the IS field were focused more on the university context of HE compared to the underprivileged TVET colleges and other HE modes. Given the differences in educational environments and delivery patterns, there is a need for research in TVET colleges that validates how DOI components influence students' behavioural intention, as well as the actual use of mobile learning technology.

Gap 6. Ineffective policies and institutional preparedness.

Technological readiness varies significantly between South African rural and urban areas, where differences in accessibility and cost persist as challenges. Programs such as data-free mobile instant communication for learning have potential as ways to promote equal access, but there is less evidence on the implementation of such programs (Ramchurn, Roodt & Mulaji, 2021; Petersen & Arendse, 2024). This preparedness factor raises concerns about South African HEIs' capabilities and potential for effective mobile learning initiatives, given that many

students own mobile devices and are ready to learn digitally. Modern research is therefore required in TVET colleges, with a focus on a student-centred model that evaluates the capabilities of institutional policies, educators, and support teams for effective transformation.

Gap 7: Lack of studies on the influence of cultural and demographic factors.

Culture, diversity, and demographic factors shape the delivery of education in HEIs' academic environments. Few highlighted the influence of cultural and demographic elements, including language and age, on DOI elements, such as technology complexity and attitude. From a South African context, further studies are required to examine the cultural and demographic relevance of mobile content designs and their impact on adoption and continued use.

These identified gaps were crucial for South African HEIs, especially TVET colleges, providing opportunities for new knowledge and advancements that address institutional challenges, alter student attitudes and intentions, and promote adoption and continuous use. This effort will assist South African HEIs to shift beyond identified challenges and focus on developing a relevant technology-based initiative that nurtures the sustained viability of mobile learning in education.

1.5. PROBLEM STATEMENT.

South African HEIs have made significant progress in ensuring that digital technologies, such as mobile learning, become part of long-term strategies towards digital transformation. However, the majority of these HIEs still face challenges in effectively implementing mobile learning and encouraging student utilisation in educational settings. Studies conducted locally have revealed that challenges related to poor connectivity, high data costs, and institutional infrastructure limitations prevent equal access and continued usage of mobile learning, despite the widespread ownership of mobile devices (Ramchurn et al., 2021; Mabidi, 2024; Mateko, 2024). These long-term challenges play a significant role in shaping students' perceptions and decisions regarding the use of mobile technology for learning. Moreover, global studies support the notion that mobile learning has the capacity to revolutionise educational processes, such as learning, through its integration with IS, widespread accessibility, and AI-powered personalisation (Baba et al., 2024; Guo et al., 2025; Moya & Camacho, 2024). However, few studies in South Africa have provided sufficient evidence of effective implementation (Eh Redda, 2024; Mateko et al., 2025). There is a need to develop an evidence-based model that demonstrates how South African HEIs can strategically implement and continue to sustain mobile learning to support digital transformation. This model is important for guiding HEIs

during the development of fair and effective policies and the delivery of adaptive and quality education that fulfils the requirements of students and the standards of global education.

Despite these problems, crucial themes have emerged from local and global studies that were evaluated. These themes include: IS as the foundation of digital transformation (Bucăţa et al., 2022), mobile learning adoption and long-term sustainability (Alfalah, 2023; Al-Rahmi et al., 2021), completeness, fairness, and equal access (Mateko et al., 2025), AI integration and ethical Use (Baba et al., 2024; Guo et al., 2025; Moya & Camacho, 2024) and implementation and utilisation challenges (Ramchurn et al., 2021; Mabidi, 2024; Mateko, 2024). These key identified issues demonstrate how HEIs in South Africa can centralise mobile learning as an important approach to supporting digital transformation. However, these initiatives are still in development, as highlighted by the ongoing challenges and identified gaps.

1.6. THE RESEARCH QUESTIONS.

1.6.1 The primary research questions

What influences the use of mobile learning technologies by students in HEIs towards digital transformation?

1.6.2 The research sub-questions

- What factors influence students' capabilities to use mobile learning technologies in HEI?
- What challenges and opportunities exist when students use mobile learning in HEIs?
- What influences the relationship between mobile learning and digital transformation in HEIs?

1.7. THE RESEARCH OBJECTIVES.

- To examine the factors that influence learners' capabilities to use mobile learning technologies in HEIs.
- To investigate the challenges and opportunities that exist when students use mobile learning in HEIs.
- To determine what influences the relationship between mobile learning and digital transformation in HEIs.

1.8. UNDERPINNING THEORY.

Like most global studies, this study is underpinned by the lens of an IS theory. Theories and models about technological acceptance were formulated to clarify how individuals and organisations perceive, use, and maintain the utilisation of new technologies, as well as how these behaviours impact overall system success (Humairoh, Annas & Susilo, 2023). This study followed the footsteps of several studies in mobile learning by incorporating one of the well-known IS theories, such as TAM, UTAUT, ISS, and Diffusion of Innovation (DOI) theory. Each of these theories presents a distinct perspective on adoption, acceptance, and performance.

To clearly answer the research question on what influences the use of mobile learning technologies by students in HEIs towards digital transformation in South African HEIs, and to link to the study topic, the DOI theory was selected as the foundational model for analysis. The DOI theory proposed by Rogers (2003) was commonly utilised in educational technology studies to understand the spread of innovations within a social system (Chakraborty & Biswal, 2024; Menzli et al., 2022). DOI highlights the following five steps that make up the innovation adoption decision-making process: (1) Knowledge, (2) Persuasion, (3) Decision, (4) Implementation, and (5) Confirmation (Frei-Landau et al., 2022). The model will assist this study in outlining the process of technology awareness in HEIs, the formation of students' opinions, and the decision-making process regarding the adoption or rejection of mobile learning technology innovations. Moreover, it considers personal and other factors that affect how quickly and well mobile learning is adopted, such as the status of digital skills, social influence, and support from HEIs.

The decision of this study to employ DOI as its foundational theory enables the scholar to analyse both individual student behaviours and intentions, as well as patterns in the HEIs that influence the acceptance and utilisation of mobile learning technology. This decision is appropriate in understanding how mobile technologies spread through South African HEIs, the level of students' awareness, and how changes can be implemented to support an effective digital transformation initiative.

1.9. RESEARCH METHODOLOGY.

This study adopts a positivist philosophy, a deductive approach, and a descriptive quantitative design to empirically evaluate hypotheses based on the DOI theory. It further integrates a thematic literature review with an empirical investigation to assess the influence of mobile learning technologies on digital transformation within South African HEIs, specifically in the context of Vhembe TVET College.

Data collection.

The first phase of the data collection process was conducted through a survey strategy by employing a structured questionnaire. The questionnaires were made available to students at Vhembe TVET College, with some questions using a five-point Likert scale and aligned to the DOI theory. The second phase was based on secondary data, which contained 31 peer-reviewed journal publications published between 2020 and 2025, sourced from Google Scholar and Scopus. These studies were filtered according to established criteria using the recommended reporting items for systematic reviews and meta-analysis (PRISMA) guided screening approach, and several themes of interest were identified.

Sampling and target population.

The target population consisted of enrolled students at Vhembe TVET College, and a simple random sampling method was employed to identify 300 students from various programs (Business, Engineering, NCV). This process was achieved through the utilisation of Krejcie and Morgan's (1970) sample determination adequacy calculations. Following the data cleaning process of 301 distributed survey questionnaires, 242 valid responses were retained for analysis, yielding an 80% response rate.

Data analysis.

The data analysis procedure for this study was conducted using Statistical Package for the Social Sciences (SPSS). This process included procedures such as descriptive, correlational, reliability, regression, and moderation analysis. These methodological procedures guaranteed the reliability, validity, and objectivity of the results. Moreover, Exploratory Factor Analysis (EFA) and Path Analysis were employed to evaluate the robustness and significance of the associations among variables.

Ethical considerations.

The study considered the ethical aspects of modern research. The ethical approval and certificate were secured from the UNISA Institutional Research Committee, as well as the gatekeeper letter received from Vhembe TVET College. All participants provided informed consent and were guaranteed anonymity and voluntary participation.

1.10. CONCEPTUAL RESEARCH MODEL.

According to the conceptual research model, the influencing factors path (Indicated by solid lines) revealed that relative advantage, compatibility, complexity, trialability, observability, and perceived risk are mediated by attitude to influence the usage intention of mobile learning technologies in HEIs' academic settings. The controlling variables are student age, gender, and educational level.

Hypothesis development.

Figure 1 illustrates the study's conceptual model, which is based on the Rogers (2003) DOI theory. The theory highlights the process by which individuals adopt and employ developments in technology over time (Frei-Landau et al., 2022). This theory has been extensively utilised in the HE academic environment to examine adoption behaviour towards new technology (Arora et al., 2022; Menzli et al., 2022). The conceptual model enhances the adapted DOI theory by incorporating supplementary components such as attitude and perceived risk, which are significant in technological adoption and intention to use (Al-Rahmi et al., 2021; Arora et al., 2022; Kasilingam, 2020; Lutfi et al., 2022). Therefore, the role of the conceptual model in this study is to effectively define the dependent, independent, mediating, and control variables, while integrating them into theoretical structures and clarifying their contributions within the study. These components were further grouped and summarised in Table 1.1, providing the necessary definitions related to the theoretical role within the study's conceptual model.

Independent variables.

These are technological and psychological components that were employed in this study's conceptual model as the primary determinants of the usage intention of mobile learning technology in HE academic settings: these were:

Relative advantage is the extent to which users regard a specific innovation as better to its alternatives (Arora et al., 2022).

Compatibility is described as the degree to which an innovation aligns with the principles, standards, and established methods of its end users (Abdalla et al., 2024)

Complexity is the degree to which users can comprehend a specific innovation with little difficulty (Arora et al., 2022).

The element of trialability describes the degree to which users have a preference to experiment with the innovation prior to making a decision regarding its adoption (Ayanwale & Ndlovu, 2024).

Observability refers to the capacity to clearly comprehend a complex innovation or system structure (Fahad & Shahid, 2022).

The perceived risk associated with technology was initially articulated in Rogers' (2010) DOI theory, which categorises risk into sub-elements: psychological, social, performance, financial, time, and privacy dimensions (Tyrväinen & Karjaluoto, 2022).

Mediating Variable.

Attitude refers to users approval or denial of utilising a technology (Aburbeian, Owda, Owda, 2022).

Dependent variable.

Usage intention is an assessment of an individual's willingness to exert effort to accomplish an activity (Aburbeian et al., 2022).

Control Variables.

These represent corresponding demographic characteristics that are incorporated to account for variability in behavioural outcomes. The supported demographic components were gender, age, and level of education (Althunibat et al., 2021; Arora et al., 2022).

Table 1.1: Types of variables used in the study conceptual model.

Variable Grouping	**Components**	**Description.**
Independent Variables	Relative advantage Compatibility Complexity Trialability Observability Perceived risk	These signify essential characteristics that affect students' adoption choices, reflecting perceptions of the innovative aspects of mobile learning technology. The DOI theory provided these components and perceived risk to guide the prediction of usage intention of mobile learning technology in HE academic settings.
Mediating Variables	Attitude	These are the mental elements that explain how the DOI components influence the usage intention of mobile learning technology in HE academic settings.
Dependent Variable.	Usage intention	This is the predicted or result variable that demonstrates students' actual use of mobile learning technology in HE academic settings.
Control Variables	Age Gender Level of education	These are not DOI components, but are carefully regulated to eliminate demographic bias, which may affect students' attitudes and usage intentions of mobile learning technology.

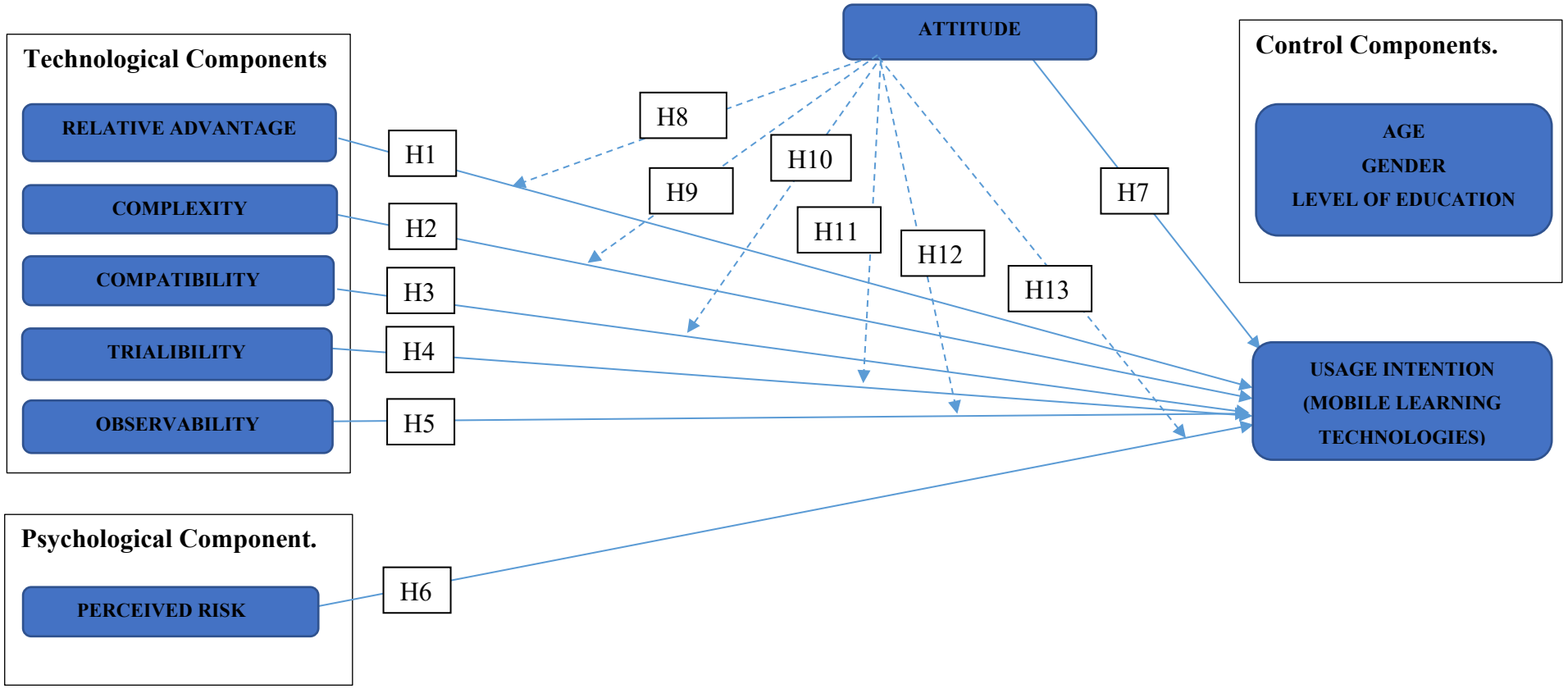


Figure 1: The conceptual research model.

1.11 HYPOTHESES.

To address the research question and clarify the objectives of the study topic, the following eight hypotheses were developed. These hypotheses comprise the influencing factors (or independent predicting factors) such as Relative advantage, Compatibility, Complexity, Trialability, Observability, and Perceived risk. The moderator included Attitude, whereas the dependent (predicted factor) was the students' usage intentions of mobile learning technologies in HE. As such, several hypotheses were developed:

H1*: Relative advantage positively affects the usage intention of mobile learning technologies.*
H2: *Complexity positively affects the usage intention of mobile learning technologies.*
H3: *Compatibility positively affects the usage intention of mobile learning technologies.*
H4: *Trialability positively affects the usage intention of mobile learning technologies.*
H5: *Observability positively affects the usage intention of mobile learning technologies.*
H6: *Perceived risk positively affects the usage intention of mobile learning technologies.*
H7: *Attitude positively affects the usage intention of mobile learning technologies.*
H8*: Attitude mediates the effect of relative advantage on usage intention.*
H9*: Attitude mediates the effect of complexity on usage intention.*
H10*: Attitude mediates the effect of compatibility on usage intention.*
H11*: Attitude mediates the effect of trialability on usage intention.*
H12*: Attitude mediates the effect of observability on usage intention.*
H13*: Attitude mediates the effect of perceived risk on usage intention.*

No hypothesis was developed for control variables, such as age, gender, and level of education; however, these variables are essential for enhancing the understanding of the impact of demographic characteristics on students' attitudes and intentions towards mobile learning utilisation. This includes providing statistics and influential adjustments between the dependent and moderating variables, as well as other variables.

1.12. KEY FINDINGS.

The findings of this study were achieved through a structured study methodology process. Firstly, the study utilised a positivist, quantitative methodology to empirically investigate the determinants affecting student adoption and usage of mobile learning technology within a South African HE context. The primary set of data was obtained through a structured, self-

administered questionnaire, which was physically distributed to 301 students using simple random sampling. This process measured demographic control elements and the independent DOI elements through a five-point Likert scale. As such, the initial findings from two campuses of Vhembe TVET College revealed that out of 301 issued surveys, 242 valid replies were obtained, resulting in an 80% response rate.

The second phase of gathering and analysing secondary data from 31 global and local studies was conducted through a thematic process following the set criteria of the PRISMA guidelines. The method facilitated the identification of significant themes and principal predictors of mobile learning adoption and use in the context of HE in South Africa. The combination of methodological and analysis approaches revealed that mobile learning technologies are becoming increasingly acknowledged as one of the foundational tools for digital transformation in HE. Mobile learning has been found to demonstrate the ability to improve student involvement, flexibility, and educational results. This platform can be further improved, especially when underpinned by theoretical frameworks such as the DOI or other technology acceptance models, such as TAM and UTAUT.

Data were analysed using SPSS, allowing the study to illustrate descriptive statistics, reliability analysis, correlations, and regression analysis to evaluate hypothesised correlations among elements. The results revealed a Cronbach's alpha of 0,871, indicating the strength of internal consistency. Following the refinement of the Exploratory Factor Analysis (EFA), five variables were identified as consistent with the conceptual model, including relative advantage, compatibility, observability, attitude, and usage intention. The correlation results indicated moderate associations between relative advantage, compatibility, observability, and usage intention, whereas attitude was a significant predictor of the relationship. Regression, hypothesis testing, and mediation analyses demonstrated that relative advantage, compatibility, and observability significantly impacted usage intention solely when mediated by attitude. This clarified the important role of attitude in students' adoption behaviour. The path analysis and model fit indices aligned with these findings, as well as the statistical assumptions, which were validated.

HEIs in South Africa can benefit from the integration of mobile learning and AI, leading to more personalised learning, flexible learning, and continuous education, even in the midst of significant issues related to ethical utilisation, privacy, and security. Despite many students in

South Africa owning mobile devices, local studies revealed ongoing challenges, including high data costs, poor connectivity, and inequalities between privileged and underprivileged institutions. These challenges hinder the transformational efforts of HEIs and lead to students' unfair utilisation of mobile learning tools.

Overall, the findings have revealed that mobile learning can significantly transform learning and other HEI academic processes. However, students in South African HEIs often face challenges that delay utilisation and successful digital transformation efforts. The development of fair policies, strategies, and government support can help HEIs promote and initiate sustainable mobile learning.

1.13. CONTRIBUTION -THEORETICAL, METHODOLOGICAL AND PRACTICAL.

Theoretically, this research enhances the current global and local literature on mobile learning, IS, digital transformation, and HE by utilising the DOI theory. This theoretical contribution identifies applicable factors and adoption characteristics relevant to the South African context, providing reasons why these factors are particularly relevant locally. This information enhances the local understanding of mobile learning technologies in resource-constrained educational environments. Furthermore, it highlights the significant limitations and opportunities associated with the use of mobile learning, aligning with literature about the improved accessibility, flexibility, and collaborative learning characteristics of mobile learning. This contribution substantially offers policymakers and HEIs solid evidence that supports a strategic focus on digital transformation efforts.

Methodologically, the study contributes to the fields by utilising a systematic thematic literature review based on the PRISMA guidelines. It provided a synthesis of results from recent research, conceptual, and systematic review studies conducted between 2020 and 2025. Furthermore, the study employed thematic interpretation and theoretical guidance, such as DOI, to establish a solid analytical foundation. This method helps in understanding the theoretical perspective, the challenges and opportunities unique to students, and existing relationships between mobile learning and digital transformation in HE.

Practically, the study offers factual guidance and solid information to strategists and policymakers in South African HEIs. The study identifies the significant challenges, benefits, and opportunities related to the use of mobile learning by providing guidelines for HEIs' digital transformation strategies. This is achieved by emphasising fairness, cost-effectiveness, and the

sustainable integration of mobile technologies. These can assist HEIs in making strategic and informed investment decisions to enhance infrastructure, develop digital skills, offer free mobile services and connectivity, and create new mobile learning platforms integrated with AI. This will ensure that South African HEIs meet the demands to deliver high-quality education, and students benefit from mobile learning that is accessible, sustainable, and relevant.

1.8 SUMMARY

This chapter introduced the field of IS as the foundation of digital transformation and developed the mobile learning concept. It further provided a critical definition of key terms, as well as emphasising the significance of the research within the setting of South African HE. Important research gaps were identified during the assessment of the background to the research problem, enabling the scholar to develop the research problem statement, research questions, and research objectives. The study further elaborated on the theoretical perspective through the lens of the DOI theory, and briefly illustrated the important aspects of research methodology, hypotheses, and the conceptual research model. Ultimately, the key findings were presented, along with the study's stance on its contribution to both global and local literature.

CHAPTER 2 – REVIEW OF RELATED LITERATURE.

Chapter Organisation	
❖	Introduction
❖	Synthesised studies literature review (theme analysis).
❖	Reviewed studies' implications based on theory, country context, and methodology.
❖	Additional literature gaps with implications for the current South African study.
❖	Literature links to the study's conceptual model and developed hypotheses.
❖	Chapter summary.

2.1 INTRODUCTION

The utilisation of mobile learning has become increasingly important in online education settings (Frei-Landau et al., 2022). This chapter examines mobile learning literature to offer a thorough comprehension of the digital transformation concept in the local and global HE. This was achieved by incorporating the synthesis of modern research from 2020 to 2025, including reviews, conceptual, and empirical studies. This was done to understand the perspectives of these studies on what is already understood regarding the mobile learning transformation of HEIs, the factors that promote adoption and sustained utilisation, theories, countries, and methodologies. Moreover, the context and challenges that affect developing countries, such as South Africa, are important. The study conducted a comprehensive literature review methodology to synthesise and examine the application of these technologies within HEIs and the overall impact on students' attitudes and intentions.

Search strategy and data source.

This review search strategy primarily concentrated on literature studies published between 2020 and 2025 based on predetermined inclusion and exclusion criteria. It utilised journal sources from systematic reviews, empirical studies, and case analyses downloaded from the Google

Scholar database. Hence, to enhance reliability, targeted searches were conducted on the Scopus database to verify the inclusion of matching journal articles. The articles' text keywords were used to retrieve the included and excluded articles based on the set criteria. The keywords used for inclusion were: "adoption," "artificial intelligence," "AI," "mobile-based AI," "Digital transformation," "education," "innovation," "mobile learning," "mobile technology", "students," "students' attitudes," "students' intentions," "technology." These search terms were slightly modified for the database to strengthen the inclusion criteria and ensure consistency. A cumulative total of 203 articles was obtained from the two databases. All records were retrieved and examined utilising the PRISMA approach. Ultimately, the study employed theme analysis to identify recurring and significant categories of challenges affecting students' intentions to accept mobile learning in HEIs.

The criteria used for journals' inclusion were:

- The academic work should be published in a peer-reviewed journal article, empirical studies, systematic reviews, or conceptual assessments about student adoption, attitudes, emphasising mobile learning within the HE space.
- The journal article should have been published between 2020 and 2025.
- The journal article should have been written in English.
- The full version of the publication is available and is not an abstract-only journal article

Therefore, journal articles that failed to meet the inclusion criteria were not included in this study.

Procedures used for screening and eligibility.

The procedure was a multi-stage process, from the initial search and removal of irrelevant items and duplicates, through analysis and eligibility testing, to final inclusion. The initial search retrieved 203 journal articles after undergoing an abstract and title screening process. The removal of duplicates resulted in 133 remaining items. Removing irrelevant items that did not meet the inclusion criteria resulted in 83 remaining items for thorough examination and analysis. In the end, 31 items remained after meeting the eligibility testing and were recommended for thematic analysis. The whole procedure is further highlighted in Figure 2.

Procedure for data extraction and analysis.

The extraction process involved creating an Excel spreadsheet for collecting, converting, and managing data. The items covered were authors, year of publication, applicable theory, encountered challenges, and applicable methodology. The analysis was conducted using a thematic process comprised of six stages: familiarisation, code formulation, topic generation, theme review, theme definition and naming, and report creation (Braun & Clarke, 2006). This was used in integration with the SLR selection framework was developed according to the PRISMA (Al-Qaysi, Mohamad-Nordin, Al-Emran, 2020, Zhao, Pinto Llorente, Sánchez Gómez, 2021). These allowed the study to understand broadly the mobile learning concept in relation to digital transformation in HE.

Theoretical guidance and direction.

The explanation of the themes was directed by prevalent theories of technology adoption, specifically the DOI, with connections drawn from TAM and UTAUT. Firstly, TAM is predicated on perceived ease of use and perceived usefulness (Natasia, Wiranti & Parastika, 2022). Secondly, UTAUT emphasises performance expectancy, effort expectancy, and social influence (Menon & Shilpa, 2023), while DOI is predicated on relative advantage, compatibility, complexity, trialability, and observability (Amini & Javid, 2023). These frameworks offered a structure for connecting identified challenges and opportunities to students' behavioural patterns within the various institutional contexts.

Reliability assessment.

Although the primary database was Google Scholar, its extensive range may have contributed to publishing bias and the extraction of irrelevant information. The verification check was conducted using Scopus, another widely used database, to reduce this problem. However, this process may have excluded relevant studies that were not written in English or that did not meet other inclusion criteria. Despite comprehensive research to ascertain the reliability of the items in the thematic classification, the method remained predicated upon the scholar's or individual's interpretation.

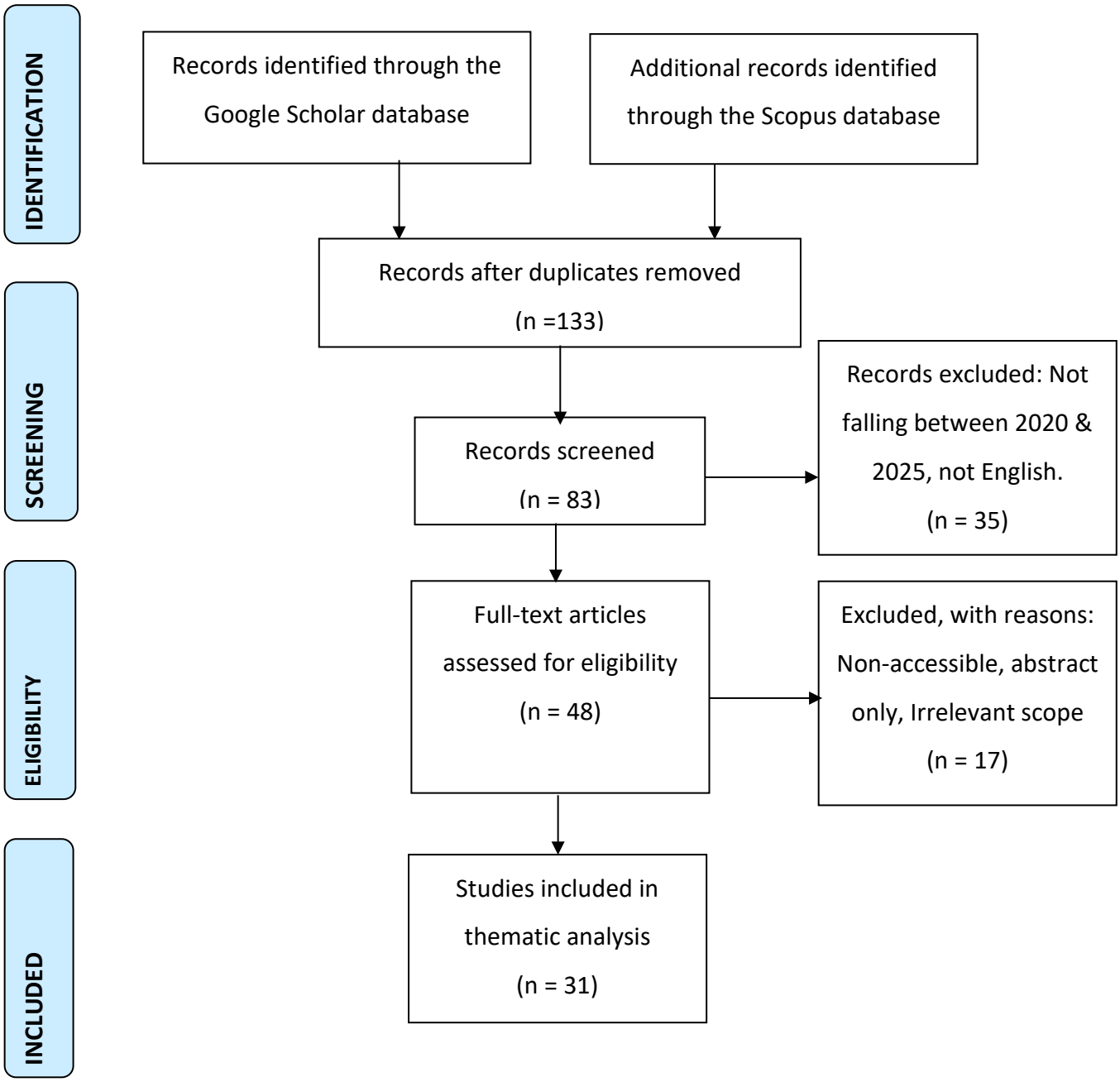


Figure 2: A schematic illustration of the procedure for searching and reviewing literature.

Table 2.1: Synthesis table of the reviewed literature

No.	Author(s)	Year	Framework	Method	Country Context	Key Findings.
1	Frei-Landau, Muchnik-Rozanov & Avidov-Ungar	2022	DOI	Qualitative	HEIs	HEI should consider students' past experiences during the adoption of new technology.
2	Qazi et al.	2024	Systematic literature review	Review	HEIs in developing countries	Mobile applications extend students' learning beyond the classroom; infrastructural difficulties hinder implementation in HEIs.
3	Sophonhiranrak	2021	Systematic literature review	Review	HEIs	The perception of device compatibility and technology affects the utilisation and engagement in mobile learning.
4	Alshurideh et al.	2023	Mobile engagement using TAM & ECM	Quantitative	UAE	Mobile technology facilitates learning at any time and enhances the integration of real-world activities into education.
5	Adzifome & Agyei	2023	The adoption model is not clear	Quantitative	Ghana	Mobile learning enhances flexibility and eliminates limitations of location in educational services.
6	Goundar & Kumar	2022	Systematic mapping	Quantitative	Global HEIs	Mobile learning applications were found to be primarily utilised for delivering educational resources at the students' convenience, in real-time or for later access.
7	Bernacki, Greene & Crompton	2020	Not mentioned	Historical review	Digital learning evolution	Mobile technology can improve educational processes and facilitate knowledge.
8	Lazaro & Duart	2023	Systematic literature review	Review	Multinational	Mobile learning has facilitated interaction in content production, communication, and cooperation between students and educators, significantly affecting learning efficacy.

9	Al-Rahmi et al.	2021	TTF, TAM	Empirical study	Malaysia	Students' views and intentions towards mobile learning indicate a positive influence on actual utilisation and its long-term viability in HE.
10	Goksu	2021	Bibliometric mapping	Review study	Taiwan, USA, China, and England	Mobile learning research is greater in HE than in lower education levels.
11	Sari et al.	2022	Not stated	Empirical analysis	Global HEIs	Educators' optimisation of e-book utilisation to enhance student learning outcomes can significantly influence students' 21st-century abilities.
12	Hameed & Sumari	2024	UTAUT2 ECM	Quantitative survey	Iraq	This suggests that peers, fellow students, educators, and university management support the utilisation of mobile learning and have some influence on learners' decisions to adopt digital tools.
13	Haleem et al.	2022	Not defined	Literature review	Global HEIs	Examined the impact of digital technologies in education, emphasising advantages, including enhanced efficiency, less pollution, refined learning methodologies, and improved student involvement. The COVID-19 epidemic increased the deployment of technology.
14	Lisana	2023	Push-Pull-Mooring (PPM) framework	Quantitative	Indonesia	Mobile devices are being embraced for their usefulness, facilitating flexible and independent learning.
15	Arini, Hidayat, Winarti & Rosalina	2022	Not clearly defined	Quasi-experimental study,	Indonesia	Students' favourable perceptions of AI-based mobile learning included two outcomes: (1) enhanced learning opportunities and (2) identified areas for improvement in novo Learning during implementation.
16	Alturki & Aldraiweesh	2022	TAM	quantitative	Saudi Arabia	The students' satisfaction with and behaviour regarding mobile learning indicated that it had a positive and beneficial impact on its real utilisation during the COVID-19 epidemic in HE.
17	Sisouvong & Pasanchay	2024	Not clearly defined	Structured literature	Global HEIs	Mobile learning facilitates self-directed, personalised education; provides flexible, on-demand access; presents obstacles such as the

				review		digital divide; and fosters lifelong learning and educational adaptation.
18	Baba et al.	2024	Engagement Theory, Lang Chain	Qualitative	Morrocco	Mobile technology improves personalisation, engagement, and academic performance.
19	Moya & Camacho	2024	Bibliometric review	review	Global HEIs	Mobile learning provides instantaneous accessibility, global reach, and connectedness with interactivity.
20	Guo, Halim & Saad,	2025	Not clearly defined	Comparison experiment	China	AI-driven education improves student motivation and practical skills.
21	Criollo-C et al.	2021	Systematic literature review	Comparative analysis	Global HEIs	Limitations hinder developing nations in infrastructure and literacy; mobile learning has the potential to mitigate inequity.
22	Alzaidi & Shehawy	2022	UTAUT & ECM	Quantitative	Saudi Arabia, the UK, and Egypt	Performance expectancy, satisfaction, social influence, favourable environments, and educators' competence favourably affect students' ongoing intentions to utilise mobile learning.
23	Lutfi et al.	2022	UTAUT & DeLone and McLean model	Quantitative	Saudi Arabia	The quality of information significantly impacts m-learning satisfaction and intention, necessitating the provision of accurate, comprehensive, current, and relevant information to users, organised pedagogically.
24	Alfalah	2023	UTAUT	Quantitative	Saudi Arabia	learners are consequently more likely to embrace mobile learning if individuals see that university management is dedicated to offering support when necessary and that using online resources is straightforward and basic.
25	Lai, Saab & Admiraal	2022	Integrative Model of Behaviour Prediction	Quantitative	China	Attitude and subjective expectations significantly increased students' intention to use mobile technology; however, self-efficacy did not directly affect this intention.
26	Bucăţa, Popescu & Tileagă	2022	Not clearly stated	Review	Romania	Higher education institutions must demonstrate considerable flexibility to adapt to digital advancements and transformations

						swiftly.
27	Landa, Zhou & Marongwe	2021	Not stated	Qualitative	South Africa	Socio-economic inequalities impact the future strategies of HEIs to deliver instruction and learning via online platforms.
28	Sunday, Adesope & Maarhuis	2021	Not stated	Meta-analysis	Global HEIs	Smartphone addiction adversely affects learning and academic performance; increased phone usage during study sessions deteriorates outcomes; psychological and academic abilities are compromised.
29	Althunibat et al.	2021	DeLone and McLean's IS Success Model	Quantitative	Jordan	The quality of the system, service, and content profoundly influences satisfaction and ongoing usage.
30	Al-Rahmi et al.	2022	TAM	Quantitative	Malaysia	Demonstrate that functionality, interaction, and reactivity together enhance student motivation and attitude through mobile learning systems.
31	Mhlanga	2023	No stated	Review	South Africa	The use of ChatGPT in education necessitates adherence to privacy, equity, non-discrimination, and openness, along with additional considerations.

2.2 SYNTHESISED STUDIES LITERATURE REVIEW.

The study identified five relevant themes that reflect global and South African interests in mobile learning, AI, and digital transformation studies. These themes include: IS as the foundation of digital transformation (Bucăţa et al., 2022), mobile learning adoption and long-term sustainability (Alfalah, 2023; Al-Rahmi et al., 2021), completeness, fairness, and equal access (Mateko et al., 2025), AI integration and ethical Use (Baba et al., 2024; Guo et al., 2025; Moya & Camacho, 2024) and implementation and utilisation challenges (Ramchurn et al., 2021; Mabidi, 2024; Mateko, 2024). Thus, this study synthesised results from 31 global studies and aligned them with the South African HE focus, while incorporating the reviewed studies' perspectives of theory, context, country, and methodology.

2.2.1 INFORMATION SYSTEMS AS THE FOUNDATION OF DIGITAL TRANSFORMATION.

The global HE literature has generally recognised IS as the foundation of institutional digital transformation. Previous research has indicated that the successful integration of information systems enhances efficiency in educational processes, administration, and the delivery of services, thereby facilitating data-driven decision-making and learner-centered methodologies (Bucăţa et al., 2022; Criollo-C et al., 2021). IS has the potential to facilitate the integration of mobile learning platforms, administrative databases, and other learning management systems, which is essential for transforming HE processes in delivering quality education while meeting the education industry 4.0 standards. This education 4.0 initiative was instituted for future educational institutions to enhance learning and adequately equip the forthcoming generation for success (Haleem et al., 2022).

According to the 31 synthesised IS research studies, most scholars utilised theoretical frameworks such as the TAM, UTAUT, or ISS models, establishing a relationship between elements including perceived ease of use, perceived usefulness, system quality, and satisfaction, and students' behavioural intention. Nevertheless, only one study by Frei-Landau et al (2022) utilised the DOI theory to investigate the spread of innovations within a social system or the influence of institutional culture on adoption. Moreover, most of these studies favoured quantitative survey approaches, indicating a lack of longitudinal research on the spread of IS

distribution in HEIs. This is notable in developing countries where there are differences in infrastructural and operational capabilities.

2.2.2. MOBILE LEARNING ADOPTION AND LONG-TERM SUSTAINABILITY.

Mobile learning adoption and implementation in HE has the potential to enhance educational processes in the long term, and HEIs should continue investing in the sustainability of the transformative strategies. Most of the analysed studies confirm that mobile learning improves flexibility, engagement, and accessibility in HE. These mobile learning advantages are critical for changing students' behaviour and promoting continuous use. According to these studies, and based on the students' learning perspective, mobile learning has the capacity to:

- *Provide learning mobility and flexibility* – students could choose when, where, and how learning would occur without geographical constraints (Alfalah, 2023; Al-Rahmi et al., 2021; Alturki & Aldraiweesh, 2022; Lazaro & Duart, 2023; Sisouvong & Pasanchay, 2024).

- *Enhance convenient accessibility to learning materials (learning independence)* – the beneficial feeling of mobile learning involved the location flexibility, efficiency in time and effort, along with the convenience and accessibility of lecture materials (Arini et al., 2022; Qazi et al., 2024).

- *Enhance student motivation and involvement* – the mobile learning approach increased students' motivation and engagement, giving them greater control over the academic journey and a more profound attachment to the issue (Baba et al., 2024; Sari et al., 2022).

- *Provides autonomous and personalisation of learning* – mobile learning provided a self-directed learning mechanism to students with a real-time learning experience, increasing engagement in subject matters and tasks (Arini et al., 2022; Sisouvong & Pasanchay, 2024). Educators were able to give students individualised help and resources that satisfy the unique requirements by customising the learning process (Baba et al., 2024).

From a DOI theoretical perspective, factors such as relative advantage, compatibility, and observability have been shown to have a significant impact on adoption and use; however, complexity and perceived risk often delay technology adoption and implementation in HEIs. The continued use is affected by attitude, satisfaction, and institutional support, validating the

significance of TAM and UTAUT frameworks in highlighting determined engagement (Alturki & Aldraiweesh, 2022; Alzaidi & Shehawy, 2022).

Despite these favourable mobile learning advantages, the sustainability and continuous use of mobile learning remain a challenge, particularly in underprivileged or developing countries, where technological resources are limited. The continuous use of mobile learning is often connected to student behavioural intentions. However, studies from these developing countries suggest that the sustainability of mobile learning also relies on institutional preparedness, focused investments, and fair polices. For example, a South African study by Mateko et al (2025) noted this problem, emphasising the need for the strategic incorporation of mobile learning within comprehensive digital transformation frameworks to ensure improvement and continuity.

2.2.3 MOBILE LEARNING COMPLETENESS, FAIRNESS, AND EQUAL ACCESS.

The aspects of completeness, equity, and equal access are vital aspects of mobile learning research. These aspects were notable in developing countries such as Ghana, Iraq, and Malaysia. According to research in these countries, device ownership did not ensure utilisation, as the affordability of mobile internet and connectivity constituted a significant challenge (Goksu, 2021; Goundar & Kumar, 2022; Hameed & Sumari, 2024; Lutfi et al., 2022). For example, incorporating mobile devices as educational resources highlighted the inequality between users with access to high-speed connectivity and those without (Lazaro & Duart, 2023). Equity and equal access are not simply technological concerns; these aspects represent socio-economic and societal problems that illustrate inequities between advantaged and disadvantaged HEIs. As such, HEIs with effective IS infrastructures demonstrated an increased rate of mobile learning adoption and continuous usage, confirming the view that technological preparedness is essential for digital transformation. Goundar & Kumar (2022) and Mhlanga (2023) had suggested that developing countries needed to necessitate policy consistency, wherein government leadership, telecommunications regulators, and HEIs work together to guarantee accessibility.

Other studies have clarified that the successful implementation of mobile learning is dependent on the digital competencies of users (Alturki & Aldraiweesh, 2022; Criollo-C et al., 2021). This signifies that strategies must be formulated to promote the enhancement of digital competences,

creating a balance between privileged and underprivileged students to achieve equity and equal access to digital resources.

Although mobile technologies helped alleviate limitations in time and location, local studies indicated that unequal access to infrastructure and connectivity data extended educational inequities (Mateko et al., 2025; Shumba et al., 2025). This digital gap was exposed during the pandemic, where historically disadvantaged HEIs faced greater challenges regarding device accessibility, connectivity reliability, and digital skills proficiency. Therefore, from a developing country context, relevant data from studies in Saudi Arabia, Malaysia, Jordan, Indonesia, and Ghana, as well as South African research, underscore the structural inequality and the necessity for free access and available assistance.

Theoretically and methodologically, few studies highlighted equity in the incorporation of the DOI or TAM frameworks, despite its significance to students' technology adoption outcomes. Similarly, the methods used by these studies lacked comparative analysis to highlight equity patterns within countries. These equity gaps can be addressed in South African HEIs by developing fair policies, government involvement, zero-cost educational platforms, and public-private collaborations that guarantee affordability and accessibility. This study has also noted the impact of perceived fairness and completeness on students' actual utilisation and attitudes.

2.2.4. MOBILE LEARNING INTEGRATION WITH AI AND ETHICAL USE.

Nowadays, an increasing number of studies have investigated the integration of AI into mobile learning, illustrating that these technologies can enhance personalisation and autonomy in learning. AI-powered mobile learning has significantly enhanced mobile learning via personalisation, intelligent feedback, and adaptable learning approaches (Baba et al., 2024; Guo et al., 2025). This integration of mobile learning applications with AI technologies has offered a substantial opportunity to improve and enhance digital learning experiences, even though challenges related to privacy, trustworthiness, and ethical use are aspects of consideration (Moya & Camacho, 2024). The utilisation of generative AI technologies, such as ChatGPT, brought up additional issues, including algorithmic bias, academic integrity, and data privacy (Mhlanga, 2023). Nevertheless, these innovations were associated with enhanced performance, engagement, and autonomous learning (Arini et al., 2022), allowing learners to collaborate with educators and others within the academic community.

From a theoretical perspective, AI-enhanced research expands familiar acceptance models by incorporating other elements such as trust, perceived security, and ethical awareness. This suggests that utilising theories like the TAM and the DOI helped improve understanding of personal technology adoption (Al-Rahmi et al., 2021; Arini et al., 2022). These theories provided assistance by clarifying essential elements related to students, including attitude, behavioural intention, convenience, effectiveness (Al-Rahmi et al., 2021; Alturki & Aldraiweesh, 2022) and views of the system regarding relative advantage, compatibility, complexity, observability, and trialability (Frei-Landau et al., 2022). The DOI theory provides a theoretical underpinning for understanding this cycle through its five adoption stages: knowledge, persuasion, choice, implementation, and confirmation (Frei-Landau et al., 2022).

Most of the reviewed studies (including AI-based international studies) employed quantitative methodologies, conceptual reviews, or comparison experiments, highlighting a lack of methodological and ethical impact evaluations within African HEIs. Moreover, these studies assessed perception rather than behaviour, resulting in an insufficient of understanding of how the students shift from intention to the actual utilisation of the AI-powered mobile learning technology. Therefore, South African HEIs should implement strategies that include effective privacy and data security measures to alleviate concerns and promote utilisation. This forms part of the responsible integration of AI with mobile learning, which is a crucial aspect of sustainable digital transformation, and provides insight into the student's shift from adoption to utilisation.

2.2.5 MOBILE LEARNING IMPLEMENTATION AND CHALLENGES.

The systematic analysis of these studies demonstrated that mobile learning may transform academic processes by improving accessibility, flexibility, personalisation, engagement, performance, and learning outcomes. Nonetheless, implementation of digital transformation initiatives is often associated with various challenges, including inadequate institutional support, ineffective educational strategies, technological obstacles, insufficient digital literacy, psychological resistance, and social influences. These categories of challenges were identified by several analysed global studies. for example:

Lack of digital competencies and digital infrastructure:

Several studies revealed that a significant challenge facing HEIs, particularly in developing nations, is the limited access to technology tools. This includes infrastructure, device

compatibility, and internet accessibility. Students in regions with inadequate digital infrastructure were more vulnerable to these gaps, resulting in digital inequality (Alzaidi & Shehawy, 2022; Criollo-C et al., 2021; Landa, Zhou & Marongwe, 2021). Many scholars highlighted the significance of acquiring diverse 21st-century technology skills as a pathway to success in an era characterised by rapid and dynamic global development (Sari et al., 2022). Likewise, the lack of technological skills created an impression that technology was difficult to use, hence reducing individuals' willingness to continue using it (Alturki & Aldraiweesh, 2022; Bucăţa et al., 2022; Goundar & Kumar, 2022; Lai et al., 2022). This lack in digital literacy is often associated with individuals' technical skills and familiarity with technological tools, frequently impacting students' confidence in navigation, psychological well-being, and attitudes. Consequently, HEIs needed to formulate strategies that enhanced students' digital proficiency and promoted investment in sustainable infrastructure, which is vital for the acceptance and utilisation of mobile technology (Sophonhiranrak, 2021).

Attitudinal and psychological challenges.

Psychological and attitudinal issues, including low motivation, limited understanding of technology, fatigue associated with technological use, and mental overload, had frequently influenced individuals' adoption of new technologies (Alfalah, 2023; Al-Rahmi et al., 2021; Alturki & Aldraiweesh, 2022). As such, the beneficial impacts of technology addiction on students' educational outcomes may be linked to the transformation of social behaviours that normalise excessive technology usage (Sunday, Adesope & Maarhuis, 2021). According to Lai et al (2022) and Goundar & Kumar (2022) the aftermath of the pandemic revealed another significant academic challenge, namely the students' psychological fatigue resulting from excessive time spent on online platforms. These issues are closely linked to challenges in academic methodologies, such as limited cooperation and the absence of a centred mobile interface design, which makes mobile learning experiences appear less valuable (Bucăţa et al., 2022; Hameed & Sumari, 2024). The latter aligns well with findings from similar studies indicating that students who view mobile learning as complicated or mentally challenging are less motivated to participate actively in mobile learning initiatives. This aligns with the complexity and perceived ease of use elements in the DOI and TAM (Arora et al., 2022; Chang et al., 2022). Modifying these psychological and attitudinal factors might enhance students' mental well-being and foster classroom interest and engagement.

Cultural, economic, and social influence elements.

Previous research has revealed several issues, including increased costs, concerns about information quality, and cultural or linguistic differences that reduce relevance for specific student demographics (Alzaidi & Shehawy, 2022; Criollo-C et al., 2021; Goundar & Kumar, 2022). Social influence, cultural factors, and economic accessibility can significantly impact students' attitudes and intentions towards technology adoption, particularly in environments where peer motivation is lacking. Encouraging peer relationships and dynamic cultural communities of practice motivated students to adopt mobile learning initiatives (Frei-Landau et al., 2022). From a South African perspective, with its diversity of cultures and languages, these challenges were particularly evident where educational resources and mobile interfaces often failed to accurately represent the social realities of students (Mabidi, 2024; Mateko et al., 2025).

Previous studies have demonstrated a significant influence of success anticipation, social influence, and facilitating environments on learners' adoption and use of learning technologies (Alzaidi & Shehawy, 2022). This underlined the significance of facilitating conditions as a key predictor of learners' intention to utilise mobile learning technologies (Alfalah, 2023). These aspects significantly affect students' views and behavioural intentions regarding technology adoption, aligning well with the UTAUT framework. Therefore, HEIs should create strategies that support economically disadvantaged students, value diverse cultures and languages, promote collaboration, and offer free connectivity mechanisms to students. This move guaranteed that all students received equitable benefits from digital transformation activities (Bucăţa et al., 2022).

2.3. REVIEWED STUDIES' IMPLICATIONS BASED ON THEORY, COUNTRY CONTEXT, AND METHODOLOGY.

Theoretically, the concepts of mobile learning adoption and sustainability can be effectively highlighted with guidance from technology acceptance models. These include DOI, TAM, UTAUT, ISS, and ECM. This study utilised the DOI as the primary theory to understand students' perspectives from the knowledge stage to the confirmation stage. It further incorporated the significance of TAM and UTAUT by gaining insight into students' attitudes, intentions, satisfaction, system or content quality, and social influence (Al-Rahmi et al., 2021; Alshurideh, Kurdi, Salloum, Arpaci, Al-Emran, 2023). The ISS further incorporated various

quality factors, including system quality, information quality, and service quality, alongside user satisfaction, intention to use, and net benefits (Lutfi et al., 2022). On the other hand, the ECM model highlighted that users' satisfaction and perceptions of information systems and services, which significantly affect continuation intention, were profoundly influenced by the degree of confirmation regarding the actual utilisation of the system and service (Alzaidi & Shehawy, 2022; Hameed & Sumari, 2024). However, these theories provided less guidance on the perceived risk related to ethics, privacy, and trust, which are becoming increasingly evident in relation to AI.

It is also evident from the country's context that most studies originate from Asia and the Middle East, with limited occurrences in African contexts. This gap can be addressed through South African research that emphasises equity, affordability, and digital capabilities. This review of literature adds to the knowledge of research by using age, gender, and level of education as controlling variables in understanding digital transformation by using mobile learning in the educational settings of several South African HEIs.

Methodologically, these reviewed studies on the mobile learning domain were primarily characterised by surveys and reviews. This meant that the usage intentions of mobile learning were monitored inconsistently, leaving a need for longitudinal, multi-stakeholder, and impact studies derived from different research methodologies. This can significantly address limitations in South African studies by providing a clear understanding of adoption strategies, free accessibility, and how students and staff should be developed. This highlights the significance of the study's thematic focus, DOI guidance, and emphasis on students' usage intentions, which may later lead to the actual utilisation of mobile learning as a digital transformation initiative.

2.4. LITERATURE GAPS WITH IMPLICATIONS FOR THE CURRENT SOUTH AFRICAN STUDY.

The current study employs DOI, incorporating linkages to TAM, UTAUT, ECM, and ISS. It aims to assess students' behavioural usage intentions and examines the moderating effect of attitude, statistically controlled by age, gender, and level of education, to illustrate contextual diversity in South African HEIs. This study identified other categories of notable gaps that

highlight the importance of comprehensive transformation strategies aimed at the promotion of mobile learning in South African HEIs. These include:

Institutional gaps relating to the insufficient number of studies that provide clarity on the incorporation of mobile learning into the HEIs' transformation strategies, such as governance, quality assurance, and funding modes. There is also a need for specific research that deals with the integration of AI aspects, such as privacy, bias, and transparency, within South African HEIs. Moreover, these studies were dominated by student-focused surveys, providing limited information on educators, administrative staff, and the active relationships involved in implementing and managing the transformation.

Secondly, limitations regarding equity and technology affordability were not clarified, as most of these studies were not causal in nature. As a result, it is challenging to determine the relationship between free technology accessibility and usage intentions. This gap might limit the institution's ability to provide strategic intervention. Ultimately, these studies also lacked longitudinal analysis that would clarify the sustainability of mobile learning and its continuous use over time. Students' attitudes and behaviours change over time and can directly influence continuous utilisation.

2.5. LITERATURE LINKS TO THE STUDY'S CONCEPTUAL MODEL AND DEVELOPED HYPOTHESIS.

The suggested conceptual model developed in this study describes the mechanism by which students in HEIs accept and utilise mobile learning technology in digitally transformed academic settings. As such, the thematic synthesis of the examined papers assisted this study in constructing the directive conceptual model and providing guidance based on a valid theoretical foundation. For example, this study's conceptual model was derived from the DOI theory, with significant support from the TAM and UTAUT theories, which provided additional insight.

According to Rogers (2003), the elements of the DOI theory employed in this study's conceptual model, including relative advantage, compatibility, complexity, trialability, and observability, represent the independent variables that impact students' attitude and usage intention of mobile technology in an academic setting. Related evidence from previous studies supports that these variables have significantly influenced the students' perceptions of value, usability, and willingness to adopt new learning technology (Al-Rahmi et al., 2021; Alfalah, 2023; Frei-

Landau et al., 2022). Moreover, the addition of perceived risk and attitude, alongside DOI elements drawn from the findings of TAM and UTAUT, suggested that students' views on the usefulness of technology, ease of use, and peer social influence affected usage intentions and continued utilization (Alturki & Aldraiweesh, 2022; Alzaidi & Shehawy, 2022). The incorporation of perceived risk covers students' perceptions regarding technology utilisation fears, such as privacy, data security, ethical use, and dependability. These were factors that are becoming critical with the incorporation of AI into mobile learning environments (Mhlanga, 2023; Baba et al., 2024).

According to the conceptual model and insights from TAM and UTAUT, the usage intention element serves as the predicted factor by the DOI elements, providing a prediction of students' different behavioural stages until the technology's use. This also connects to the attitude element, allowing scholars to understand students' position towards technology usage. Furthermore, this study highlighted the cultural and language diversity within South African HEIs, allowing us to acknowledge that technology use varies among student groups. As such, controlling variables that influence students' perceptions were identified, including gender level of education and age. This was supported by previous studies indicating that the younger students frequently display greater adaptability and receptiveness to technological developments; however, gender inequalities may influence self-efficacy, digital competence, and perceived effectiveness (Arini et al., 2022; Lai et al., 2022). Meanwhile, the level of education was linked to students' mental understanding and the complexity of technology while navigating the interface.

Finally, understanding the connections and links in this study model clarifies how students' attitudes develop and how they influence the behavioural usage intention, which is crucial for achieving sustainable digital transformation objectives in HE. This is significant for South African HEIs that have embarked on technology-centered, transformative strategies.

2.6. CHAPTER SUMMARY

This thematic literature analysis synthesised findings from 31 global studies and linked them with the focus of South African HE, combining the theoretical, contextual, country, and methodological perspectives. The thematic results indicated that mobile learning is a legitimate catalyst for digital transformation, dependent on IS competence, equitable access, supporting educational methods, and responsible AI. The evidence from the studies is theoretically

consistent but methodologically limited, as most were quantitative and reviews. These studies were geographically dominated by Asian countries with a focus outside of Africa. The chapter concludes by highlighting the link between the DOI theory and examining the significant determinants affecting the students' usage intentions of mobile learning technology in South African HEIs. The analysis warrants consideration of identified gaps, which are affected by the moderating variable, demographic controllers, and can be applied practically within the academic setting of South African HEIs.

CHAPTER 3 – UNDERPINNING THEORY/MODEL

Chapter organisation	
❖	Introduction
❖	Theoretical framework
❖	Diffusion of Innovation Theory
❖	Conceptual model
❖	Summary

3.1 INTRODUCTION

The theoretical perspective is considered a key significant element of our educational research activities. This was the primary theoretical paradigm for describing how users applied IS artefacts to achieve goals in technology systems usage, which prioritises the role of humans in the connection between users and IS artefacts (Baird & Maruping, 2021). The theoretical framework highlights the occurrence under scrutiny and reflects the researcher's underlying presumptions (Luft, Jeong, Idsardi & Gardner, 2022). The goal is to gain insight into the influence of mobile learning technologies on students at Vhembe TVET College, considering their interaction with technology systems.

Every considered theory provides a distinct perspective on the acceptance and success of mobile technology tools. The adoption and success of the scholar can also be achieved by integrating two or more theories within a single study. For this reason, the study provided a comparative analysis of some widely used IS theories and offered reasons for not adopting and for adopting a particular theory.

3.2 COMMON INFORMATION SYSTEMS THEORIES.

This section of the study discusses common IS theories employed by scholars in positivist research. These theories provided an important insight into the development of the study's conceptual model.

Table 3.1: Comparative analysis of theories related to this study.

Theory	Key Elements	Theory relevance for this study	Benefits of the theory for this study	Limitations of the theory for this study
TAM (Sutiyono et al., 2024)	Perceived usefulness. Perceived ease of use Behavioural intention Attitude. Actual system use. (Natasia et al., 2022)	describes students' acceptability and intention to utilise mobile learning tools in HEIs.	It is a thoroughly proven and scholarly approach for technology acceptability. It provides ease in describing students' behavioural intention in mobile learning.	It concentrates exclusively on users' perception and is limited in providing clarity on contextual or institutional elements, like the diffusion of new technology throughout HE systems. It fails to clarify the dissemination or communication of new technology among users, a process that is adapted from this study using the DOI.
UTAUT (Humairoh, Annas & Susilo, 2023)	Performance expectancy. Facilitating conditions. Effort expectancy Social influence Intention to use	It helps describe students' behavioural engagement and external factors affecting mobile learning technologies.	It integrates many models such as TAM, Theory of Planned Behavior, and Theory of Reasoned Action. offering a broader perspective on social	UTAUT is limited by its description of the user's intention rather than the technology diffusion process, which is crucial to this DOI-based study. Due to its

	(Menon & Shilpa, 2023)		and institutional factors.	comprehensive nature, it also requires certain contextual characteristics, such as age, gender, experience, and other aspects, which were not included in this study.
Delone & Mclean (Sutiyono et al., 2024)	system quality. Data quality. Service quality. Intention to use. User satisfaction. Net benefits. (Bayastura et al., 2022)	It evaluates the effectiveness of mobile learning systems based on quality, utilisation, and satisfaction indicators.	It offers significant insights for assessing the long-term feasibility of the system and user satisfaction, which is relevant for evaluating system performance.	This theoretical approach aims to assess the technology's success through a post-feasibility evaluation, rather than clarifying the processes of technology acceptance and spread. This study is limited by its focus on system results, whereas DOI clarifies the various stages that users undergo before and during the actual interaction with the technology.
TTF tasks (Natasia, Wiranti & Parastika, 2022)	Task characteristics. Technology characteristics. (Almusawi & Durugbo, 2024)	It assesses the extent to which mobile learning technology facilitates students' academic tasks.	Assists in evaluating the alignment of mobile technology with academic and institutional requirements, crucial for South	It does not take into account the psychological and social factors that influence students' decisions to adopt. TTF is based on the fact that

			African studies.	technology is already implemented and leaves out how it is spread, awareness, or attitudinal changes. What TTF overlooks are all important aspects to DOI, indicating the spread of technological Innovations.

Comparative analytical comments and conclusion based on Table 3.1.

- The theoretical analysis of the four theories revealed some aspects of relevance as well as limitations related to this study. The comparison of these theories aimed to determine if the objectives of this study would be met in relation to the adapted DOI theory. TAM, UTAUT, ISS, and TTF were limited in capturing the spread of technology innovation, with the focus on student behaviour and system effectiveness. Hence, the DOI enabled this study to examine the student shift across different stages, such as from awareness of technology to its adoption and use. This provided a crucial understanding in the context of South African HEIs where cultural and language diversity impacts students' awareness, accessibility, digital competence, and institutional readiness. DOI was relevant for this study as it provides an opportunity to examine both individual and institutional perspectives, such as trialability (students) and observability (institutional). The DOI capabilities were further enhanced by incorporating elements of attitude, perceived risk, and usage intention to enhance its contextual explanation.

- Table 3.1 provided a clear reason behind the four theories excluded from this student learning focused study. These reasons include a lack of technology spread characteristics (TAM), data requirements not suitable for this study (UTAUT), post-utilisation focus (ISS), and assumption on an already implemented task fit technology (TTF).

- Based on the comparison, it is concluded that the limitations arising from the four excluded theories hinder the study's capacity to meet its objectives and address the research question. Consequently, DOI was chosen since it facilitates the inclusion of logical decision-making phases in mobile learning adoption and the relationship between students' perceptions and institutional context, both of which are essential in the digital transformation of HEIs in South Africa.

3.2.2 The Technology Acceptance Model.

One model that examines technology adoption is the TAM, which uses several elements to determine how people feel about using technology (Sutiyono, Bakhri, Ulyanti, Ningsih, & Syukur, 2024). The TAM emphasised five key elements essential to users' acceptance of technological innovation: perceived usefulness, perceived ease of use, behavioural intention,

attitude, and the actual system use (Natasia et al., 2022). However, for this study, two key elements are discussed below, with the other three scrutinised together with the leading adopted theory.

- The element of perceived usefulness indicates the extent to which a person users that utilising a technology innovation could help them carry out tasks and enhance performance (Wicaksono, Maulina, Rizal & Purnomo, 2023). This means that students at Vhembe TVET College had to hold a particular belief that using mobile technology applications in an academic environment would help enhance task completion and academic performance.
- The element perceived ease of use is a metric that measures how simple it is for people to comprehend and operate technology innovations (Natasia et al., 2022). Thus, the simplicity of a technology innovation and the operational understanding measure how students perceive the technology as easily usable or user-friendly. Vhembe TVET College students need knowledge to understand technology innovation and its operations, and determine if the technology is easily usable.
- External variables influence the above two elements in the TAM. These external variables influence the perceived ease of use and perceived usefulness; examples include system attributes, user experience, target design, trust, security, system features that enhance user effectiveness, and learning informed by feedback or individual user factors such as age, gender, technological proficiency, educational attainment, and computer usage training (Chatzopoulos et al., 2022).

This study did not choose this theory, as it does not address other elements that determine students' perception of the spread of technology in HEIs, ultimately leading to the change in intention and use of a technology innovation. However, some of the main elements, such as behavioural elements and attitude, were later used in the study's conceptualisation of the model.

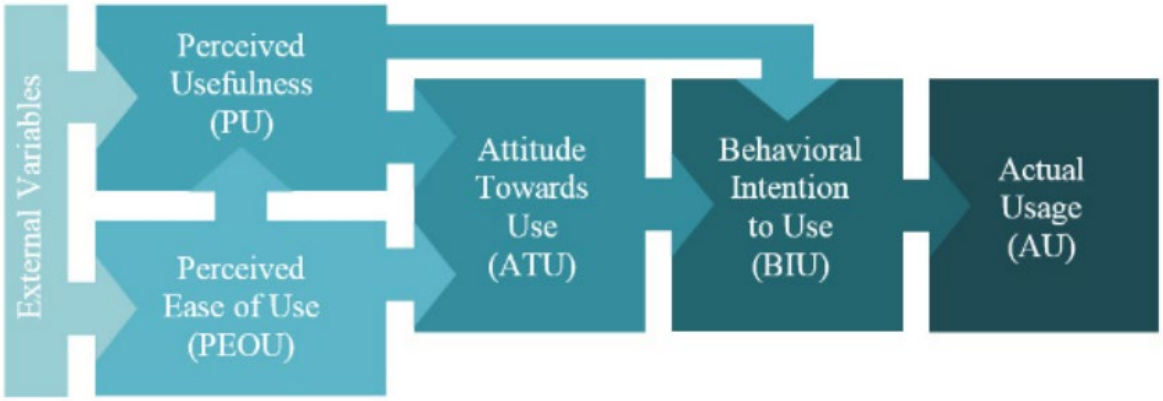


Figure 3: Technology Acceptance Model (TAM)

Source (Chatzopoulos et al., 2022)

3.2.2 The Unified Theory of Adoption and Use of Technology

The UTAUT emerged as one of the most sophisticated and widely integrated theories of technology innovation adoption, as it incorporates the most valuable concepts from various older theories and models (Humairoh, Annas, Susilo, 2023). According to a study by Menon and Shilpa (2023), UTAUT had several elements, such as intention to use, social influence, performance expectancy, effort expectancy, and facilitating conditions, which were used to thoroughly examine the usage of technology innovations.

- Performance expectancy is defined as the degree to which users believe that using the technology innovation will benefit their work (Chen, Wang, Fang & Wang, 2023). For this study, students had to believe that using mobile technology will significantly benefit academic work and performance.
- A facilitating condition is the degree to which users have reliable assistance from sufficient facilities and the degree to which individuals have faith in the accessibility of institutional and technical infrastructure to enable the usage of technology system innovation (Bayastura et al., 2022). This is the degree to which students believe that Vhembe TVET College can provide organisational and technical infrastructure that is accessible to assist in using technology innovation. For example, the college can provide technology gadgets such as laptops and access to internet connectivity platforms.
- Effort expectancy is nowadays often understood as the ease of use of a technology innovation, which is related to its operational state (Al-Mamary, 2022). This relates to

students' comfort with using mobile phones and the various technological applications attached to them. Any level of discomfort may hinder a student's acceptance of a technological innovation.

- Social influence measures how much students feel that using the technology innovation is as important as others think it is (Teng, Cai, Gao, Zhang & Li, 2022). This is an important element, as social relationships between students and other community members, such as educators, family members, friends, and peers, can influence the acceptance of technological innovations. Conversely, unfavourable social impact can support a user's resistance to change and raise questions about the efficacy and dependability of digital technology (Menon & Shilpa, 2023). Therefore, if most students at Vhembe TVET College rely on social community members to make technology acceptance decisions, these students are likely to be driven by the perceptions and thoughts of others.

Although UTAUT is an integrated theory and capitalises on the special qualities of older theories, this study did not adopt it, as it seems complex and would require additional data from the organisation and the social community concerning the students. However, the theoretical guidance on other influential elements has been noted to assist this study in meeting its objectives.

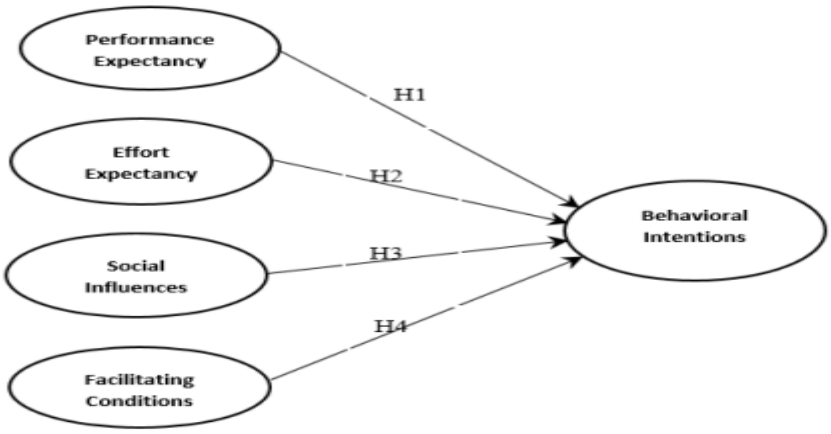


Figure 4:The UTAUT framework Source: Matar, Al-Jaber & Matar (2024)

3.2.3 DeLone and McLean.

The DeLone and McLean ISS theory is similar to the TAM, a theory for examining technology innovation effectiveness (Sutiyono et al., 2024). DeLone and McLean's model considered the

following elements: system quality, data quality, service quality, intention to use, user satisfaction, and net benefits (Bayastura et al., 2022). This study highlights the three elements of system quality, data quality, and service quality of technology innovation separately from intention to use, user satisfaction and net benefits. The system quality element emphasises the technology system's functionality and usability; the data quality element takes into account the desired features of a technology system output; whereas the service quality element assesses how well the technology developer supports system end users (Çelik & Ayaz, 2022). These three elements are sometimes more technical for non-expert individuals, such as college students, to observe. Hence, this study argues that students at Vhembe TVET College may find it challenging to measure system quality, service quality, and data quality of an accepted technology innovation. As a result, it would be beneficial for the HEI responsible for adopting the technology to be involved in overseeing the success of the innovation system.

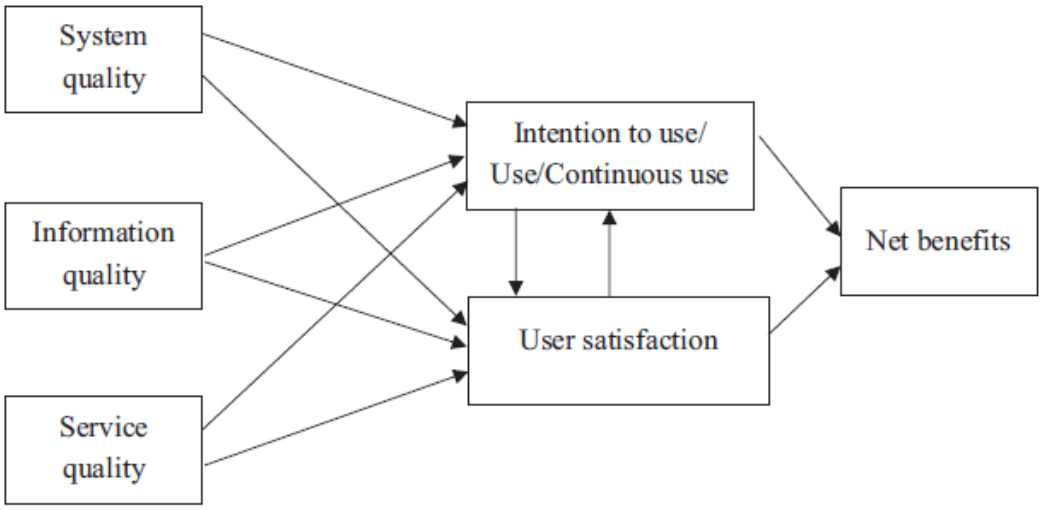


Figure 5: DeLone and McLean framework Source: (Jami Pour et al., 2022)

The other two elements of this theory, intention to use and user satisfaction, are similar but distinct, even though they sometimes influence each other. The element of intention to use refers to the degree to which the user perceives or uses a technology innovation to complete several functions, whereas the element of user satisfaction describes the level of happiness users have with a technology system (Bashiri, Shirdeli, Niknam, Naderi & Zare, 2023). These elements are often seen as measures of technology effectiveness when users complete tasks.

The perception of students regarding the functions performed through mobile technologies can lead to either student satisfaction or dissatisfaction with the effectiveness of the technology.

Finally, the element of net benefit draws attention to how technological innovation affects the achievement of people, teams, businesses, industries, and countries (Jami Pour, Mesrabadi & Asarian, 2022). This is a key success measure element that is crucial in ensuring the successful implementation of mobile learning technologies. When students are pleased with technology's impact on academic activities, intentions to use and engagement with the technology increase.

According to Kendle and Chipangura (2024), as indicated by this theory, service quality affects both system use and user satisfaction, which means that good service quality satisfies end users, even though some empirical studies validated the service quality element and found conflicting results. This theory could have been helpful in this study to examine the elements that influence the perceptions of Vhembe TVET College students on the successful utilisation of mobile learning technology applications, services, and impact on the quality of education delivered. However, this study argues that some elements of this theory were not easily attained using students' perspectives only, and it also has a limitation in covering the elements related to students' technology acceptance, which may later lead to the use of the technology.

3.2.4 Task technology fit

Based on the TTF theory, information technology innovation can only be utilised when its benefits and features can help users complete tasks (Natasia et al., 2022)**.** According to the TTF principle, the extent to which a task and the technology being utilised to achieve it fit well affects both performance and acceptance (Alyoussef, 2023). Consequently, the theory is based on task and technology characteristics as two unbreakable components that function together to form a fit for better performance (Almusawi & Durugbo, 2024). This means that students' usage of mobile learning technology applications to achieve tasks brought by educators at Vhembe TVET College must fit well together. Moreover, HEIs and educators need to develop tasks compatible with mobile technology applications' characteristics to ensure that performance and acceptance can be attained.

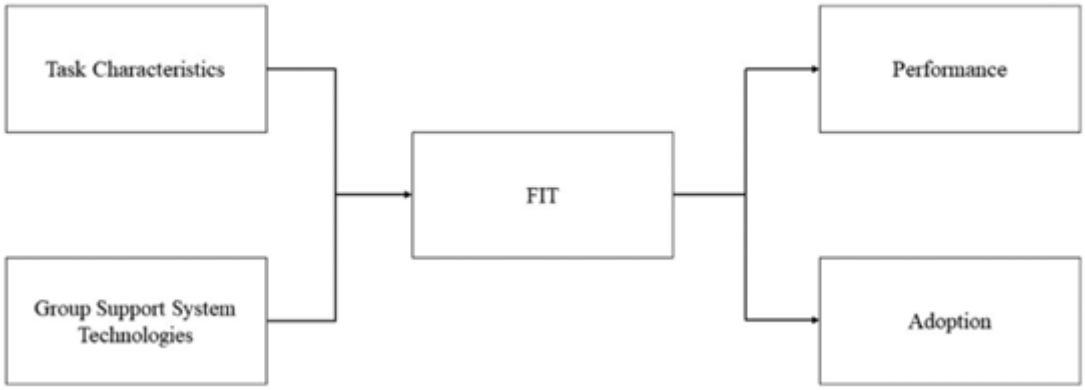


Figure 6: The general TTF framework Source: Mumtaz, Bergey and Letch (2024)

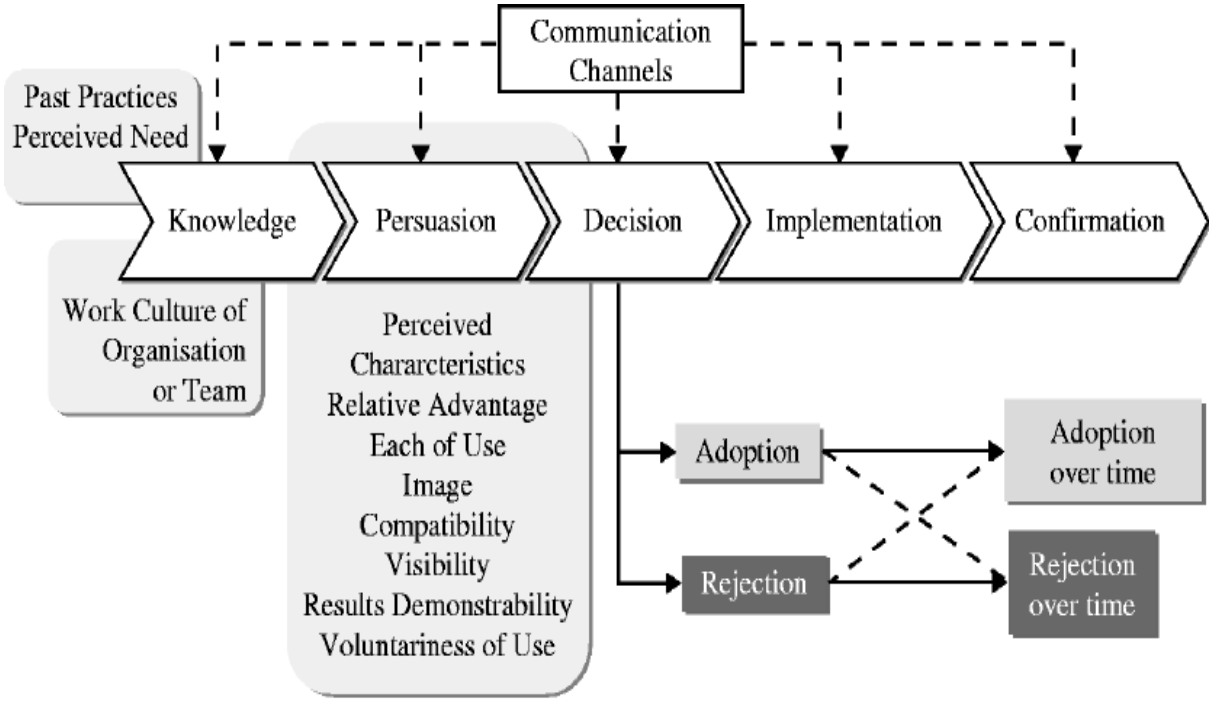
HEIs are responsible for planning for a fitting task and technology to attract usage. It is thus implied that the technology system's planned utilisation is required for its practical use (Humairoh, Annas & Susilo, 2023). The perception of students at Vhembe TVET College of using mobile technologies for completing academic tasks is more likely to be favourable if students see a match between the task and technology characteristics. Therefore, this study argues that the TTF theory could have been helpful for this study, but lacks the application of social elements unless integrated with other theories. Understanding elements such as attitude, intention to use, and how students perceive the risks of using the technology is necessary to address the research question. As a result, another theory that fitted well with the study was selected.

3.3 DIFFUSION OF INNOVATION THEORY

Theories and models about technological acceptability have been formulated to examine how people view and embrace new technologies, how they might be utilised, and the effects of continued use (Humairoh et al., 2023). Each theory provides a distinct perspective of individuals and organisational technology adoption, acceptance, performance, and overall system success. This study addresses the research question through the lens of the DOI. This study chose this theory because students' decision to adopt and accept a technology innovation goes through several stages until the utilisation is confirmed. Moreover, the stages help us understand the spread of technological innovation in the academic environment of HEIs.

The DOI is one of the most popular models put forth by Rogers (2003) for analysing how an innovation is communicated across the stakeholders of a system (Menzli, Smirani, Boulahia & Hadjouni, 2022). He defines DOI as the procedure through which a social system's stakeholders

gradually learn about an innovation through specific channels (Chakraborty & Biswal, 2024). This theory assisted this study not only in understanding students' decisions to adopt mobile learning technology but also in comprehending the overall process of adopting and using the technology. Hence, the DOI is comprised of the following five steps that make up the innovation adoption decision-making process: (1) Knowledge, (2) Persuasion, (3) Decision, (4) Implementation and (5) Confirmation (Frei-Landau et al., 2022). This means that students' decision-making process comes from being aware of the technology, being persuaded to use it, experiencing its usage, and judging its performance and outcomes. Scholars can better understand the characteristics of students when using mobile learning technologies, including the skills and capacity for the adopted innovation and the level at which students regard the innovation adoption.



Source: Rogers (2003)

Figure 7: Representation of the DOI Model Source: Rogers (2003).

According to the DOI theory, an innovation has a higher chance of being adopted if it shows superior qualities to the item or technology it replaces and is in line with the standards, values, and anticipated needs of the target end users (Isman, 2023). Like other theories, the DOI has its key focus elements for assessing the spread of an innovation. These five elements, with essential

characteristics for innovation, are relative advantage, compatibility, complexity, trialability, and observability (Amini & Javid, 2023). They affect how students make decisions and the rate at which innovation is accepted and utilised. Thus, the five elements are discussed in detail when the study conceptualises the framework and highlights the hypothesis in the next section.

3.4 THE CONCEPTUAL RESEARCH MODEL

This study developed a conceptual model to provide a picture of mobile learning utilisation to support digital transformation in HEIs and enhance the understanding of the knowledge delivered from the adapted theory. The conceptual model explains a scholar's understanding of the elements and/or factors involved in the study and how these relate to one another (Luft et al., 2022). This section discusses the conceptual elements and the hypothesis to better understand mobile technology usage in HEIs and further addresses the research question. The independent variables were anticipated to be the DOI elements responsible for promoting the utilisation of the dependent variable (Usage intention) of mobile learning technology in the HE academic environment. Attitude was included as a mediating variable since the relationship between the DOI elements and usage intention is not direct.

Dependent and independent variables.

The independent variables in this study were based on the DOI theory, enhanced by elements from various models of technology acceptance, and aimed at examining the features of modern mobile learning research. These variables include relative advantage, compatibility, complexity, trialability, observability (Amini & Javid, 2023) and perceived risk (Sim et al., 2023). The Moderator was attitude (Aburbeian, Owda & Owda, 2022). As such, the qualities of innovation observed through the DOI elements affect attitudes, and ultimately, the students' intent to use mobile learning technology in HE settings. Meanwhile, the usage intention is the dependent variable, referring to students' behavioural intent and involvement with mobile learning technologies in HE settings.

3.4.1 The contributing elements of the DOI theory.

Introducing innovations means that students must alter or deviate from traditional methods and accept new alternatives, given the effect of such innovations in academic settings compared to other traditional options. These alterations are typically caused by various factors that can influence a change in a student's attitude and perception of the risks associated with using

mobile technology in the learning environment. However, limited studies have looked at the adoption of mobile technology in South African HEIs through the lens of the DOI framework. As such, this study contributes to the existing knowledge of mobile technology adoption in South African HEIs by applying the elements of the DOI framework and integration of this with attitude and perceived risk to predict usage intentions. These elements are discussed together with the formulation of the hypothesis.

Relative advantage

Relative advantage is the extent to which users regard a specific innovation as better to its alternatives (Arora et al., 2022). Innovations that demonstrate an individual advantage in enhancing strategic performance and operational efficiency possess a greater push for adoption (Amini & Javid, 2023). It is regarded as a significant factor in the adoption of innovations and indicates how users could employ it to enhance performance on tasks (Menzli et al., 2022). Consequently, this study applies this concept to describe the degree to which Vhembe TVET College students believe that using mobile learning technology can enhance academic performance and outcomes. This occurs when students perceive the advantages of mobile learning technology as superior to the traditional classroom environment and believe that the latter can enhance academic performance and outcomes. Thus, this study hypothesised that:

H1: *Relative advantage positively affects the usage intention of mobile learning technologies.*

Complexity

Complexity is the extent to which people can comprehend a specific innovation with little difficulty (Arora et al., 2022). Innovations that are difficult to comprehend or demand mental effort are generally dismissed (Acikgoz et al., 2023). Moreover, accepting any innovations or services relies on the innovation's user-friendliness for the prospective user (Fahad & Shahid, 2022). The complexity of innovation is closely related to the skills and efforts the user has to discover, utilise, and accept (Menzli et al., 2022). In this study, complexity refers to the perceived difficulty experienced by Vhembe TVET College students, which affects their overall learning, engagement, performance, and outcomes. The lesser the complexity of mobile learning applications from the students' viewpoint, the easier it is to accept in the learning environment. The study therefore hypothesises that:

H2: *Complexity positively affects the usage intention of mobile learning technologies.*

Compatibility

Compatibility is described as the degree to which an innovation aligns with the principles, standards, and established practices of its end users (Abdalla, Bhat, Tiwari, Khan & Wedajo, 2024). It incorporates elements that align with the users' operational environment into an existing technology (Menzli et al., 2022). Similarly, compatibility can also refer to the alignment of innovations with consumers' established lives and previous experiences (Acikgoz et al., 2023). According to this study, compatibility refers to students' perspectives on the advantages of utilising the mobile learning technology applications after employing the technology in the learning environment. This means that the principles, standards, and existing learning practices at Vhembe TVET College must be compatible with the operational practices of the newly adopted innovation. Therefore, the study hypothesises that:

H3: *Compatibility positively affects the usage intention of mobile learning technologies.*

Trialability

The element of trialability refers to the degree to which users have a preference to experiment with the innovation prior to making a decision regarding its adoption (Ayanwale & Ndlovu, 2024). Trialability stays minimal until the invention is embraced, allowing potential end users to get firsthand experience and resolve uncertainties associated with early perceptions (Abdalla et al., 2024). This study's viewpoint is based on the necessity for Vhembe TVET College students to have adequate proficiency in mobile learning technology prior to its integration into various academic processes, as this impacts learning performance and outcomes. In addition, most students' learning comfort and familiarity depend on prior trial or training with educational resources before making an effective decision to accept mobile learning technology in an academic environment. Thus, the study hypothesises that:

H4: *Trialability positively affects the usage intention of mobile learning technologies.*

Observability

Observability refers to the capacity to clearly comprehend a complex innovation or system structure (Fahad & Shahid, 2022). This is a confirmation element when individuals evaluate personal experiences and seek feedback (Frei-Landau et al., 2022). Moreover, by evaluating the actual performance of these innovations, end users can better understand the surrounding

assumptions and negative opinions, while concurrently making decisions that align with their best interests (Arora et al., 2022). This means that the performance results from these innovations must be visible for students to make informed judgments and evaluations regarding the adoption of mobile learning technology. Therefore, the greater the visibility of innovation among various end users, the higher the rate of its acceptance (Menzli et al., 2022). This study hypothesised that:

H5: *Observability positively affects the usage intention of mobile learning technologies.*

Perceived risk

The perceived risk associated with technology was initially articulated in Rogers' (2010) DOI theory, which categorises risk into sub-elements: psychological, social, performance, financial, time, and privacy dimensions (Tyrväinen & Karjaluoto, 2022). However, this study focused on the general element of perceived risk and did not examine the sub-elements individually. Perceived risk is defined as the form and extent of risk recognised by an individual when considering a decision or choice (Sim et al., 2023) to adopt an innovation. According to existing scholarly evidence, individuals perceived that online technological operations were dangerous (Habib & Hamadneh, 2021). Moreover, online and mobile platforms are deemed dangerous and unpredictable due to being subject to hacking and data breaches; this risk and uncertainty affect user behaviour and raise pressure in decision-making processes (Teng, Cai, Gao, Zhang & Li, 2022). Thus, the negative perception of students towards the dangers of using technology innovation to improve performance and learning outcomes negatively affects the attitude and student intent to utilise mobile learning technology applications in academic environments. This study, therefore, hypothesises that:

H6: *Perceived risk positively affects the usage intention of mobile learning technologies.*

The mediating effect of attitude.

Attitude

Most studies have concentrated on identifying attributes that enable or obstruct the acceptance of mobile learning technologies, as well as on the attitudes and beliefs related to utilisation and the expressed usage intentions (Frei-Landau et al., 2022). Attitude defines an individual's approval or denial of utilising a technology (Aburbeian et al., 2022). It is the user assessment of the utilisation of technology innovation (Alfadda & Mahdi, 2021). This element was a

significant determinant in this study as it forecasts students' intentions that precede actual activity or decision to accept a technology innovation. Forming attitude through a positive representation of a particular innovation fosters the development of ethical action intention (Arora et al., 2022). According to a study by Fahad and Shahid (2022), which observed the DOI elements in conjunction with the components of the TAM and UTAUT models, it was revealed that compatibility and respondents' attitudes positively affected their intent to use. Similarly, the attitude towards use positively influenced the willingness to adopt technology gadgets (Acikgoz et al., 2023). Therefore, students' attitudes towards using mobile learning applications positively influence the willingness to adopt technology in the academic environment. The more visible the effect of mobile learning technology on performance and learning outcomes, the greater the positive attitude towards usage intention. Thus, the study proposes the following hypothesis:

H7: *Attitude positively affects the usage intention of mobile learning technologies.*

H8: *Attitude mediates the effect of relative advantage on usage intention.*

H9: *Attitude mediates the effect of complexity on usage intention.*

H10: *Attitude mediates the effect of compatibility on usage intention.*

H11: *Attitude mediates the effect of trialability on usage intention.*

H12: *Attitude mediates the effect of observability on usage intention.*

H13*: Attitude mediates the effect of perceived risk on usage intention.*

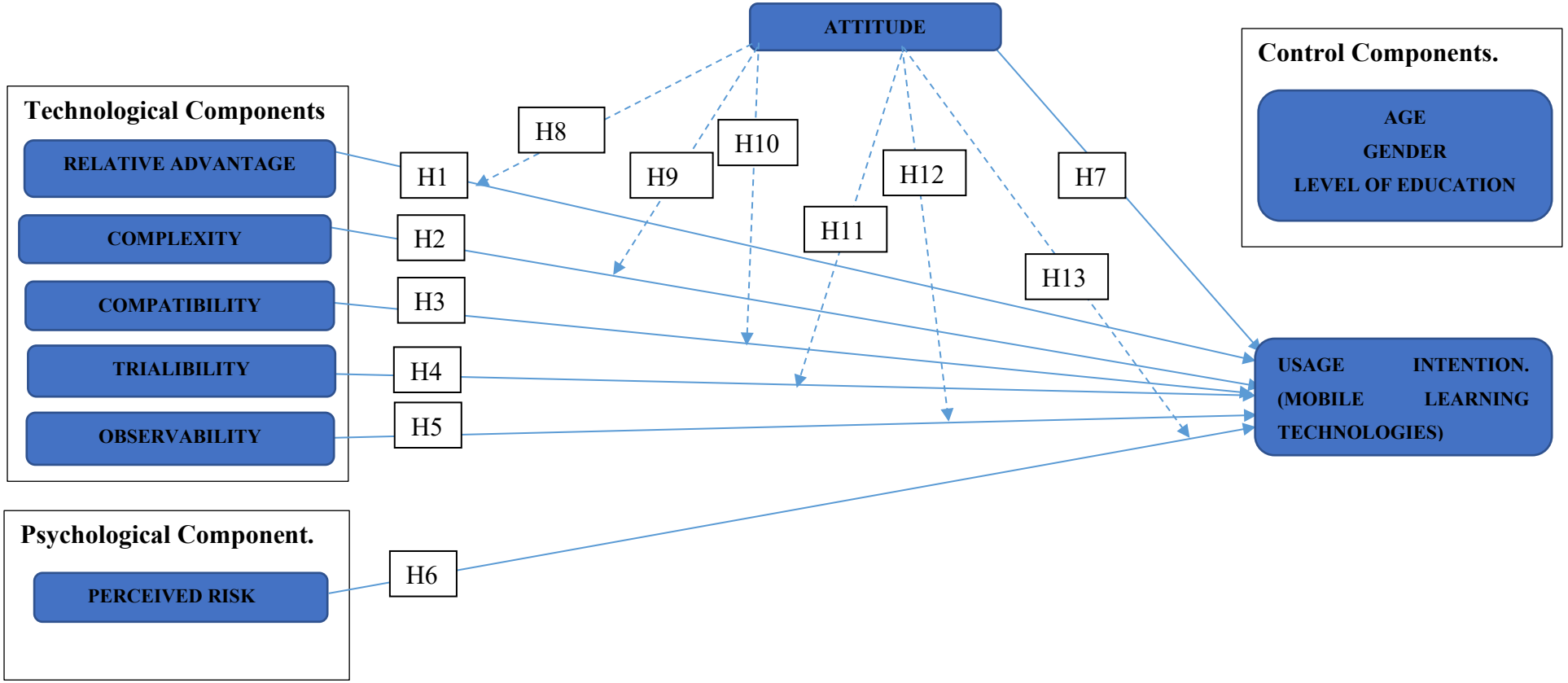


Figure 8: The conceptual research model.

Usage intention

This aspect pertains to the dependent variable of this study's conceptual model. It is a significant element in the technology domain, crucial to influencing individuals' desire to adopt technological innovations, which is referred to as usage intention in the literature, sometimes also known as intention to utilise or behavioural intention to use. Usage intention is an assessment of an individual's willingness to exert effort to accomplish an activity (Aburbeian et al., 2022). It is further referred to as the extent to which users' careful preparation for executing a future task may affect various elements, including students' usage intentions to utilise technology in educational processes (Al-Mamary, 2022). Thus, alongside the individual's intentions and behaviours, the successful acceptance of technology is affected by external conditions and factors that either promote or hinder its utilisation (Menon & Shilpa, 2023). Mobile technology applications that offer significant engagement and entertainment mechanisms are more likely to be beneficial and enjoyable for students, thereby enhancing their desire to accept and utilise the technology.

The control effect of age, gender, and level of education.

Although no hypotheses were tested regarding the control effects of age, gender, and level of education, these elements had a significant impact on the DOI primary variables. These variables were used to augment the survey explanation, revealing why and how students were using mobile learning technology. Scholars have extensively examined the impact of gender on technology acceptance and utilisation (Alfadda & Mahdi, 2021). These differences in men and women have been identified in numerous domains of technology use (Terblanche & Kidd, 2022). Consequently, gender serves as a strong factor in the associations (Bayastura et al., 2022) between the DOI elements, attitude, and intention to utilise mobile learning technology. Previous studies have found conflicting results regarding the relationship between gender and technology adoption. For example, a study by Alfadda & Mahdi (2021) indicated that girls exhibit lower confidence in computer-related skills than boys. Whereas, a study by Terblanche and Kidd (2022) revealed that women prioritised the computer's performance more significantly, whereas older individuals found the effort required to use the computer to be a barrier to adoption.

The age factor, which considers whether individuals are younger or older when adopting technology, is another significant factor in most scholarly studies. For example, according to Menon and Shilpa (2023), younger individuals engaged in HE demonstrates reduced worry regarding privacy issues and seem to possess an enhanced feeling of achievement. Another study (Angelini, 2023) confirmed that the younger individuals have greater motivation to learn skills that complement new technology, but older individuals find it less advantageous to enhance talents in a setting of technological advancement characterised by a downward professional modification.

Table 3.2: Hypotheses table.

***H1**: Relative advantage positively affects the usage intention of mobile learning technologies.*
***H2:** Complexity positively affects the usage intention of mobile learning technologies.*
***H3:** Compatibility positively affects the usage intention of mobile learning technologies.*
***H4:** Trialability positively affects the usage intention of mobile learning technologies.*
***H5:** Observability positively affects the usage intention of mobile learning technologies.*
***H6:** Perceived risk positively affects the usage intention of mobile learning technologies.*
***H7:** Attitude positively affects the usage intention of mobile learning technologies.*
***H8**: Attitude mediates the effect of relative advantage on usage intention.*
***H9**: Attitude mediates the effect of complexity on usage intention.*
***H10**: Attitude mediates the effect of compatibility on usage intention.*
***H11**: Attitude mediates the effect of trialability on usage intention.*
***H12**: Attitude mediates the effect of observability on usage intention.*
***H13**: Attitude mediates the effect of perceived risk on usage intention.*

Actual Use.

The conceptual model does not accurately reflect the actual use, as it was not captured in the collected data. Consequently, the statistical study analysed using SPSS focuses on the determinants of usage Intention as the predicted element. The actual use describes the degree to which individuals interact with and utilise a technological system in their practical duties or scholarly pursuits following the adoption decision (Venkatesh, Morris, Davis & Davis, 2003). In this study, 'actual use' refers to students' realistic behavioural involvement with mobile learning technologies in HEIs' academic setting. This includes the level of interaction with mobile applications, devices, and learning management systems. Moreover, the practical utilisation of mobile learning entails students accessing digital course materials, participating

in mobile exams, interacting with classmates and educators, and employing digital applications to improve educational learning experiences (Alfalah, 2023; Al-Rahmi et al., 2021). This study interprets actual use as the degree to which students at Vhembe TVET College actively and consistently interact with mobile learning technologies for academic purposes. This helps to reflect students' behavioural patterns, intentions, and attitudes regarding the implementation of digital learning in HEIs. Consequently, the practical application from a DOI (actual use) perspective reveals the extent to which the technological breakthrough has effectively circulated within HEIs' academic environments and been accepted by students.

3.5 CHAPTER SUMMARY

This chapter discussed the different theoretical frameworks and conducted a comparative examination of the theories used in the literature regarding technology adoption in HEIs. These theories included the TAM, UTAUT, TTF, DeLone, and McLean. Ultimately, the DOI theory was selected to inform the development of the study's conceptual model. The discussed DOI-technological elements (independent variables) were relative advantage, compatibility, complexity, observability, trialability, and the psychological element of perceived risk. Moderating variables included elements such as attitude and usage intention, as well as actual use, as the dependent variable. It further highlighted the importance of controlling variables, such as age, gender, and level of education, and the statistical influence these variables have on other model variables. The chapter concluded by developing several hypotheses to be tested in the next chapters. The chapter that follows is the research methodology.

CHAPTER 4 – RESEARCH METHODOLOGY

Chapter organisation	
❖	Introduction
❖	Research philosophy
❖	Research approach
❖	Research strategy (unit of analysis, population and sampling, data collection, procedures, and data analysis)
❖	Chapter summary

4.1 INTRODUCTION

This chapter provides a thorough analysis of the research methods applied in this study and related fields. It provides an overview of the steps used to investigate the research problem and research question, and to ascertain how mobile learning technology can effectively transform HEI environments in South Africa. Therefore, research methodology is generally understood to be a methodical and structured procedure for gathering, evaluating, interpreting, and presenting data to address particular issues or provide answers to certain questions (Hazari, 2023).

4.2 RESEARCH PHILOSOPHY

There is extensive literature on educational research paradigms and techniques, along with their philosophical underpinnings, which can sometimes prevent authors from selecting a particular research strategy, despite the numerous developments (Mulisa, 2022). Research philosophy is primarily concerned with psychological thinking and its significance for developing and expanding knowledge (Mbanaso, Abrahams,. When comprehended and accepted, the research philosophy is utilised to provide potential solutions to research issues, prompting academics to move beyond merely restating existing methods and concepts (Gannon, Taheri,. As a result, this study adopted a positivist philosophical approach to influence its design and findings.

Table 4.1: The study research table.

Research elements	**Explanations**
Research Philosophy	Positivism
Research Approach	Deductive
Research Design/Strategy	Quantitative, Descriptive Survey
Data Collection Method	Structured Questionnaire (Primary Data)
Data Source	Vhembe TVET College Students
Sampling Technique	Probability Sampling (Random Sampling)
Population	Students enrolled in Business Studies, Engineering, and NCV programmes
Data Analysis Techniques	Descriptive Statistics, Reliability Tests (Cronbach's Alpha), Correlation Analysis, and Multiple Regression using SPSS
Unit of Analysis	Individual Students
Time Horizon	Cross-sectional
Ethical Considerations	Voluntary participation, informed consent, confidentiality, and anonymity were maintained

Positivism refers to the logic of the opinions presented, showing that the knowledge produced throughout the study process exists apart from the researcher's thoughts (Mbanaso, Abrahams & Okafor, 2023). According to this philosophy, all things that cannot be understood by observation and experimentation, and some things are deemed to be made up (Maretha, 2023). Moreover, positivists distinguish between scientific and normative claims, holding that only scientific claims constitute the actual scope of the scientific method, since the senses cannot verify normative claims (Dawadi, Shrestha, & Giri, 2021). This scientific approach assisted in developing educational practices and mobile learning environments that can be useful worldwide. Thus, a positivist approach believes that other factors, such as student attitudes and intentions, influence how mobile learning systems are used, and this is the chosen paradigm for the study.

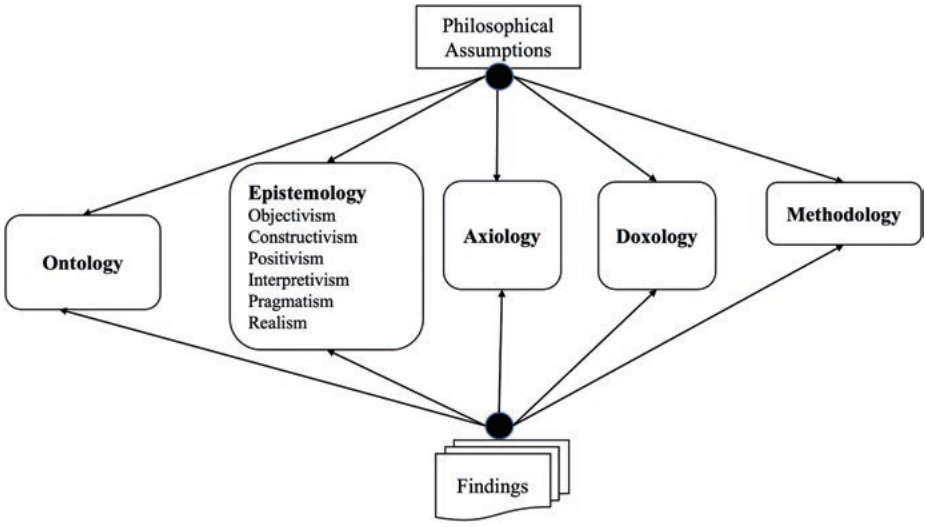


Figure 9: Research Philosophy Assumptions diagram (Mbanaso et al., 2023).

4.3 RESEARCH APPROACH

A researcher's general strategy and methods for gathering, evaluating, and interpreting data for a study are referred to as the research approach (Taherdoost, 2022). The deductive approach facilitates the testing of hypotheses derived from the DOI theory, allowing for the validation or invalidation of theoretical claims based on empirical facts. This is appropriate for a study designed to assess relationships among specified factors and analysed through statistical analysis (Al-Ababneh, 2020). For example, these factors include DOI variables, perceived risk, attitude, and usage intention. In addition, there are three most common research approaches: qualitative, quantitative, and mixed methods.

- **The qualitative approach** – qualitative research methods are investigative approaches that use nonnumerical and nonstatistical procedures for gathering, analysing, and producing information (Bhangu, Provost & Caduff, 2023). This approach is deemed open ended and not following predetermined categories or scales; participants can create categories or viewpoints regarding the questions (Hirose & Creswell, 2023). Moreover, qualitative research is better when illustrating and understanding ideas like feelings, viewpoints, and thoughts (Sardana, Shekoohi, Cornett & Kaye, 2023). Thus, this technique can contribute well to studies that need to understand a phenomenon's questions beyond the what, and including the why and the how.
- **The quantitative approach** – the use of numerical values obtained from observations to characterise and clarify the events that the observations were focusing on is known

as quantitative research (Taherdoost, 2022). The main advantages of quantitative research include the capacity to evaluate theories and hypotheses, assess causal linkages, eliminate confounding variables, predict one variable from another, speed, and the reduction of the researcher's bias (Mulisa, 2022). Therefore, this study adopted this method because it allows for testing hypotheses and establishing conclusions based on numerical data, while enabling the study to perform statistical analysis and develop correlations between variables.

- **Mixed methods approach** – this approach is common when a scholar or group of scholars combine aspects of both qualitative and quantitative perspectives for gathering data, analysis, and inference techniques and for the general goals of understanding and corroboration from a broad and deep perspective (Hands, 2022). As a result, the methodology incorporated philosophical presumptions and offered guidance for gathering and analysing data from several sources in a single investigation (Dawadi et al., 2021). This approach is common when scholars must answer questions regarding a particular phenomenon based on what, why, and how.

In conclusion, the study employed a quantitative research approach to investigate the larger Vhembe TVET College population, the hypothesis to be tested, and the determination of relationships between the chosen theory elements (the association between the independent and dependent variables).

4.4 RESEARCH STRATEGY

A research strategy is a broad outline of how the scholar would answer the study issue or questions (Mtisi, 2022). A descriptive research design was ideal for this study as it allowed the study to concentrate on the traits, frequencies, patterns, and categories found in the data collected from students. It aims to describe a concept and its features that occurred during a specific event (Hidayat, Herniawati & Ihsanda, 2022). This is a typical research paradigm employed by scholars in various disciplines, including IS. Different data collection approaches, such as surveys, observations, and case studies, can be used in the descriptive research design (Ali, Azman, Mallick, Sultana & Hatta, 2022).

A structured survey questionnaire was physically administered to students at Vhembe TVET College to gather primary data. Surveys have been particularly effective in gathering students' views, attitudes, and perceptions regarding the acceptance of mobile learning (Stantcheva,

2023). This strategy facilitated the systematic gathering of similar data from a different group of learners, ensuring representation across multiple faculties and academic levels within the college.

4.4.1 Unit of analysis

The unit of analysis represents the primary object under examination (Naseri, Hussin, Esa, Aziz & Nordin, 2021). This study analysed individual students enrolled at Vhembe TVET College. Students from several academic divisions, including Business Studies, Engineering Studies, and National Certificate Vocational (NCV), were selected to provide an extensive viewpoint on the utilisation of mobile learning technology in HE. Vhembe TVET College, situated in the Vhembe District of Limpopo Province, South Africa, represents a developing-country higher education institution facing infrastructural and digital equity challenges, making it an ideal scenario for examining mobile learning adoption.

4.4.2 Population and sampling techniques

Population.

The target population consisted of individuals, occasions, or interesting occurrences that the scholar wished to investigate (Naseri et al., 2021). This population group consisted of all enrolled students at Vhembe TVET College across various programs and academic levels. This demographic was chosen because students are the main users of mobile learning technology, and their experiences significantly influence institutional digital transformation initiatives (Lim, 2024).

Sampling strategy.

The sampling strategy is the procedure of selecting a subset from the population for a given scholarly project (Golzar, Noor & Tajik, 2024). The selection of participants was based on probability sampling, where each person in the population to be studied had an equal likelihood of being selected to participate in the study (Ali et al., 2022). Therefore, all students at Vhembe TVET College willing to participate in the study had an equal opportunity of being chosen. This improves accurate representation and minimises selection bias.

Table 4.2: The sample table.

Category	Population Estimate (N)	Sample Size (n)	Sampling Method
Engineering Studies	850	85	Random
Business Studies	1200	120	Random
NCV Programmes (Business, Engineering & other)	950	95	Random
Total	**3000**	**300**	**Random Sampling**

Sampling size determination.

According to Table 4.2, the sample size (n = 300) was determined using Krejcie and Morgan's (1970) sample size determination table, which provides a statistically valid sample for diverse population sizes at a 95% confidence level and a 5% margin of error (Chuan, 2006; Uakarn, Chaokromthong & Sintao, 2021). Vhembe TVET College has a total student population of approximately 3000; the appropriate minimum representative sample size was approximated to be 341. As such, in order to meet the standards for quantitative survey research in educational contexts (Israel, 2013), a feasible yet statistically adequate sample of 300 was selected. This was due to the temporary limitations, logistical matters, and other challenges beyond the scholar's control.

4.4.3 Data collection techniques and procedures

Data collection refers to the scientific procedures designed to collect field data necessary for testing hypotheses in quantitative research or to address research questions in qualitative investigations (Salmia, 2023). The objective of collecting data was to understand reasoning, attitudes, and viewpoints, and identify relationships (Stantcheva, 2023). The data collection process utilised primary data obtained through a standardised questionnaire administered in person to selected Vhembe TVET College students. Questionnaires are materials with statements or questions that participants or participant groups must answer in order to provide the data required to meet the study's goals (Mwita, 2022). The questionnaire comprised sections addressing demographic information, mobile learning experiences, and components from the

DOI theory (relative advantage, compatibility, complexity, trialability, observability), as well as attitude, perceived risk, and usage intention. Each component was assessed using a five-point Likert scale, with values ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Items were modified from validated instruments utilised in previous research (Al-Rahmi et al., 2021; Alzaidi & Shehawy, 2022).

The secondary data from the 31 reviewed journal studies and reviews supplemented the primary data, providing a contextual foundation. Secondary data is information that has already been gathered by another party and is easily accessible for scholars to utilise in an investigation (Mwita, 2022). This study conducted a pilot test with 30 students before the physical distribution to verify the instrument's clarity, reliability, and validity.

4.4.4 Data analysis

The following tabulated analytical procedures were employed in this study:

Table 4.3: The analysis procedure table.

Procedure/technique	**The objective of employing the procedure.**
Descriptive Statistics.	To provide a summary of demographic data and underlying trends in participants' responses, such as the mean, frequency, and standard deviation.
Reliability Analysis.	To evaluate internal consistency employing Cronbach's Alpha. For example, Cronbach's Alpha values beyond 0.70 were deemed acceptable.
Correlation Analysis.	To determine the relationships among (the independent) DOI components, perceived risk, and (the dependent) usage intentions.
Multiple Regression Analysis.	To evaluate the strength and position of the developed study hypotheses. This evaluation was conducted from H1 to H13.
Moderation Analysis.	To examine the moderating influences of attitude, controlled by age, gender, and level of education, on fundamental relationships with usage intention existing in this study.

According to Table 4.3, the data analysis process of this study was conducted using SPSS. The objective was to ascertain whether DOI theory components, such as relative advantage, compatibility, complexity, observability, and perceived risk, mediated by attitudes,

significantly influence Vhembe TVET College students' intention to use mobile learning technologies in HE settings. Moreover, the influence of control demographic variables, such as age, gender, and level of education, on these components was also examined.

4.5. CHAPTER SUMMARY

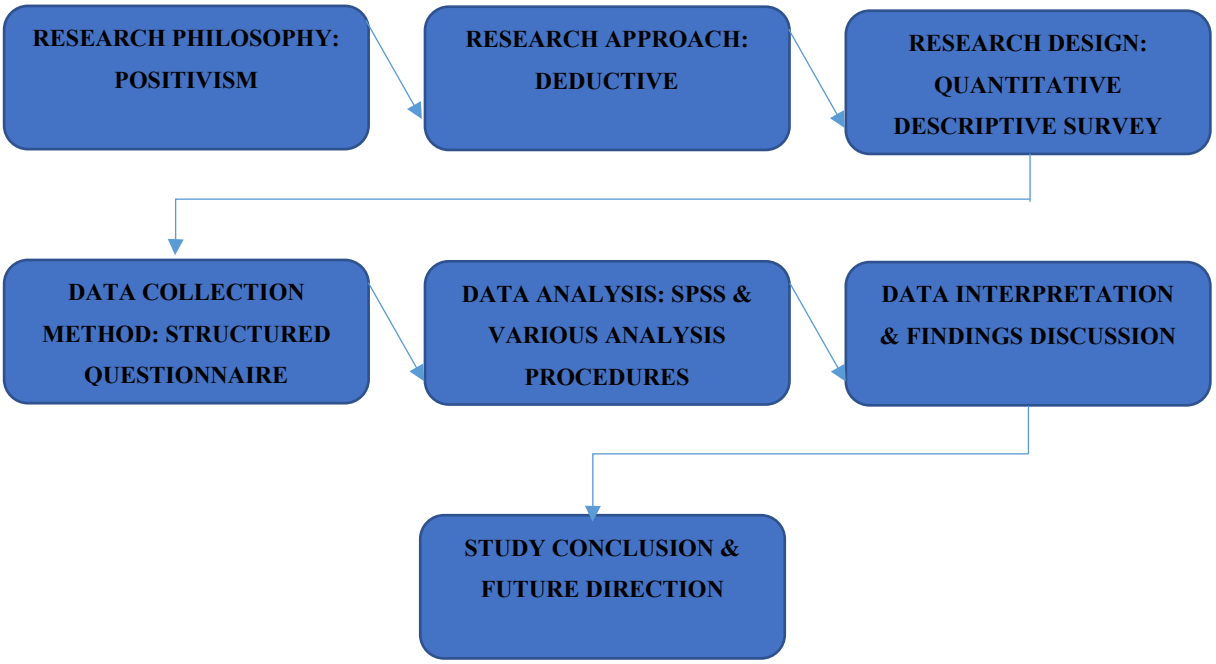


Figure 10: Summary of the study methodological structure.

According to Figure 10, this chapter outlined a brief summary of the methodology structure employed to examine students' adoption and use of mobile learning tools at Vhembe TVET College. The research employed a positivist philosophy, a deductive quantitative approach, and a descriptive survey strategy to empirically evaluate hypotheses based on the DOI theory. The data collection process was conducted through structured questionnaires with some questions based on a five-point Likert scale and analysed using SPSS. This process included procedures such as descriptive, correlational, reliability, regression, and moderation analysis. These methodological procedures guaranteed the reliability, validity, and objectivity of the results. The chapter that follows outlines the data analysis and results.

CHAPTER 5 – DATA ANALYSIS AND RESULTS.

Chapter organisation	
❖	Introduction
❖	Discussion: Participants and questionnaire information
❖	Measurement model used: Reliability and validity
❖	Preliminary testing of variables
❖	Mediation analysis
❖	Path analysis
❖	Model fit indices.
❖	Assumption checks.
❖	Summary

5.1 INTRODUCTION

This chapter addresses the specifics of the survey conducted at Vhembe TVET College. This chapter builds upon the previous section of the methodology used in this study. It further outlines the sampling method used to obtain the number of participants and the questionnaire information that was captured and used for data analysis. The survey instrument employed was tested for validity and reliability. Moreover, the chapter introduces the measurement model and thoroughly tests the developed hypotheses. Finally, the chapter discusses the analysed results, including the DOI elements, independent and dependent factors, and demographic characteristics of the study participants. Data was analysed using SPSS.

5.2 QUESTIONNAIRE INFORMATION

5.2.1 Participants and questionnaire information

The first phase of the discussion involves the questionnaire or instrument used to attain the study's goals and objectives. The instrument consisted of three parts or sections, each containing items designed according to unique characteristics and requirements to achieve the study's objectives. Demographic items, such as age, gender, field of study, and level of study, were included in Section A. The second part included items related to the participants' technology usage in academic environments, such as the device used, access to internet services, the level of technology skills, and the college recommendations for implementing mobile technologies in HEIs. Furthermore, questionnaire item number seven was answered by three participants, with the researcher taking written notes of the students' elaborations on how participants consider technology skills or proficiency level. Items that required a Likert scale were noted in section C and described on a scale of 1 (strongly agree) to 5 (strongly disagree). These items involved DOI elements, attitude, perceived risk, and the usage intentions of the participants.

Table 5.1: DOI elements and questionnaire information (Source: primary data).

DOI elements and Questionnaire Information
Relative advantage (RA)
RA1 Mobile learning improves the quality of my task completion than traditional classroom learning.
RA2 Mobile learning gives me greater control over my tasks than traditional classroom learning.
RA3 Mobile learning is more convenient when completing my learning tasks than traditional classroom learning.
RA4 Mobile learning is quicker when accessing my learning information than traditional classroom learning.
RA5 Mobile learning enhances my overall learning experiences than traditional classroom learning.
RA6 Mobile learning saves me time when attending to my learning tasks other than traditional classroom learning.
Complexity (CP)
CP1 Mobile learning needs my knowledge and understanding to use.
CP2 Mobile learning needs training and technical support to use.
CP3 Mobile learning is difficult and complicated to use.
CP4 Mobile learning is irritating to use.
Compatibility (CB)
CB1 Mobile learning suits me well with the way I want to learn and complete learning tasks.
CB2 Mobile learning is compatible with the mobile device I am using.
CB3 Mobile learning suits my lifestyle than traditional classroom learning.
Observability (OV)

OV1 I have already noticed the advantages of using mobile learning.
OV2 Mobile learning has transformed the way I learn and complete my tasks.
OV3 I have seen the advantages of owning mobile devices through mobile learning.
Trialability (TL)
TL1 I need to try and test mobile learning before using it.
TL2 I will use mobile learning after receiving feedback from those who are using it.
TL3 I will have to first check my mobile device to see if I can use mobile learning on it.
Perceived Risk (PR)
PR1 Using mobile learning is risky for my academic success.
PR2 I fear the costs of using mobile learning.
PR3 I fear using mobile learning as it risks losing my personal information.
Attitude (AT)
AT1 I am confident about using mobile learning through my mobile device.
AT2 I like using mobile learning to complete my academic tasks.
AT3 Using mobile learning is good for my academic success.
AT4 I favour using mobile learning as it has changed my personal well-being.
Usage Intention (UI)
UI1 I am confident and intend to continue to use mobile learning for my academic tasks.
UI2 I intend to use mobile learning for my future studies.
UI3 I intend to tell others to use mobile learning for their studies.

5.2.2 Questionnaire statistics

The study physically distributed 301 questionnaires between Vhembe TVET College's two primary campuses (Tshisimani and Makwarela Campus). The probability sampling method (Ali et al., 2022) was used to select 242 participants who returned the completed questionnaire, leading to an 80% response rate. A total of 59 (20%) questionnaires were never returned or were damaged. Acceptable response rates have been documented between 40% and 75% across several sectors (Sataloff & Vontela, 2021). Consequently, Creswell & Cresswell (2022) recommend that an 80% response rate is considered exceptionally high for quantitative research, providing an accurate representation and reducing bias due to lack of responses from participants.

The data collection process at Vhembe TVET College took place during students' free periods to minimise disruption of lectures and promote voluntary participation. The final dataset, following cleaning and validation in SPSS (2024), comprised purely full and logically acceptable responses. This process revealed that the 242*(n)* questionnaires were correctly filled

out and could be used for future references and other scholarly studies, thereby helping to improve the reliability and accuracy of the findings. The study found the questionnaire to be the most suitable method for testing, measuring, and investigating students' use of mobile learning technologies, as it is commonly used in mobile learning studies. This is because this tool was created based on the previously published research regarding technology adoption and mobile learning (Alfalah, 2023). Thus, this instrument provided a quantitative foundation for examining the relationship between independent variables (e.g., DOI components) and the dependent variable (usage intention) of mobile learning technologies.

5.2.3 Participants' demographic information

Participants' gender Composition.

Figure 11 and Table 5.2 present the sample gender composition of Vhembe TVET College participants. Females comprised 71,07% (n = 172) of the sample, males composed 29,75% (n = 72), and the sample did not include participants classified as Other. This signified a greater gender imbalance, with a notable lack of interest and educational access for young women from Vhembe TVET College's perspective, compared to younger males. Gender equality in TVET educational selections has been observed both in South Africa and worldwide, characterised by a significantly higher enrolment of women (Friderichs, Rogan & Needham, 2024). Moreover, this illustrates wider participation patterns in South African TVET colleges, as women increasingly surpass men in vocational programs (DHET, 2022). Therefore, the high rate of gender representation may indicate a greater interest in educational technology among female college students.

Participants' age distribution.

According to Table 5.2, the most common age range or group of participants was 20–25 years (70%), followed by 26–30 years (15,28%) and 15–19 years (11,40%). A mere 3,62% of participants were over 30 years of age, and one student with an age higher than 36 years, representing a 0,41% participation rate. As a result, a greater proportion of younger participants is anticipated in a South African TVET college setting, as these individuals typically represent the normal post-secondary age demographic composition transitioning from secondary education. This aligns well with DHET (2022) findings, which indicate that more than 1.8 million individuals aged 15 to 24 years were not in Employment, Education, or Training and have attained Grade 12 completion. Furthermore, the dominance of the 20–25 age group aligned

with a representation from a study by Sari et al. (2022), which stated the rising popularity and utilisation of digital technology gadgets in the 21st century. The prevalence of younger participants indicates a generation that is especially responsive to innovation, potentially enhancing the spread character of the DOI theory and continued utilisation of mobile learning in South African rural HEIs. As such, the likelihood of understanding the use of technologies for educational purposes rather than for entertainment (the knowledge awareness stage in DOI theory) was often related to an individual's younger age (Frei-Landau et al., 2022).

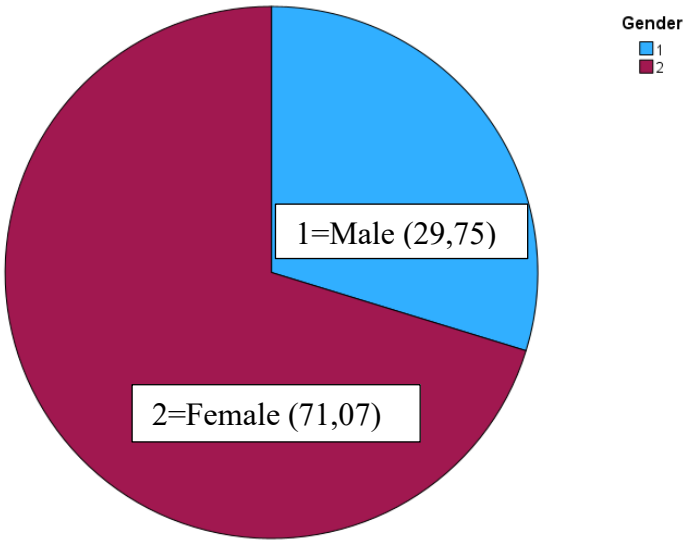


Figure 11: Participants' gender frequency information (source: SPSS 2024)

Table 5.2: Participants' gender frequency (Source 2024)

Gender	**Frequency**	**Percentage (%)**
Male	72	29,75
Female	172	71,07
Other	0	0
Age	**Frequency**	**Percentage (%)**
15 – 19	26	11,40
20 – 25	169	70,00
26 – 30	37	15,28
31 – 35	9	3,21
> 36	1	0,41

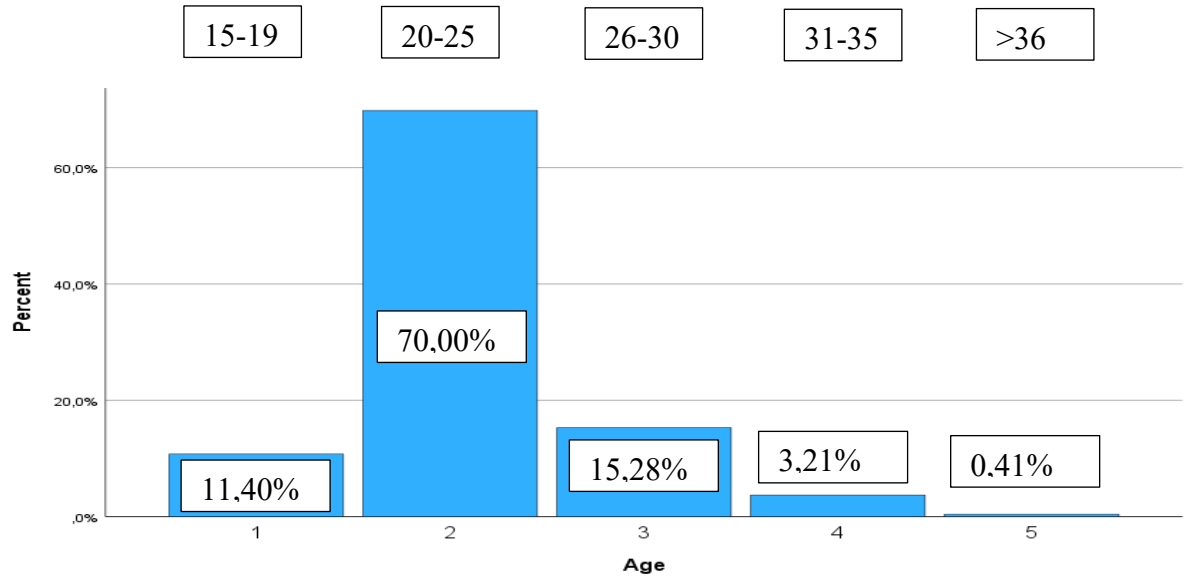


Figure 12: Participants' age groups frequency (Source: SPSS 2024)

Due to the college's geographic location being in the deep rural areas of the Vhembe district, the survey questionnaire did not consider the ethical representation of the participants (e.g. Black, coloured, white, Indian, etc.).

Table 5.3: Field of study composition. (*n*=242) (Source SPSS 2024)

Field of study	Frequency	Percentage (%)
NCV Business Studies	12	4,95
NCV Engineering Studies	11	4,54
Nated Business Studies	213	88,01
Nated Engineering Studies	1	0,41
Other	5	2,06

5.2.4 Participants' level of education

Participants' field of study.

Table 5.3 summarises another significant aspect of this study, which was to understand the educational status of the participants in terms of the field and level of studies. Students enrolled

for Report 191 Nated Business Studies rendered more responses with 213 participants (88,01%), followed by NCV Business Studies with 12 participants (4,95%), NCV Engineering Studies with 11 participants (4,54%), and Nated Engineering Studies with 1 participant (0,41%). This pattern aligns with the TVET college's program distribution, where business-related courses are the most common in enrolments, with females contributing the largest gender composition (DHET, 2022). A comprehensive evaluation of mobile learning for remote education by Lazaro & Duart (2023) revealed that the dominance of business studies students suggests that the adoption of digital technology may differ by field of study, as business programs frequently include technology-related modules, enhancing familiarity with digital technologies. Conversely, engineering studies students were mostly exposed to technical aspects, simulations, and digital drafting tools, providing another dimension of technological awareness and dissemination.

Table 5.4: Participants' level of education (Source SPSS 2024)

Level of education	**Frequency**	**Percentage (%)**
NCV level 2	2	0,82
NCV level 3	7	2,89
NCV level 4	11	4,54
N4	148	61,15
N5	30	12,32
N6	44	18,18
Other	0	0

Participants' level of study.

According to 5.4, the N4 entry level had 148 participants, contributing to a 61,15% response rate, followed by N6 and N5 levels of Business Studies with 44 participants (18,18%) and 30 participants (12,23%), respectively. The NCV Business Studies also followed Level 4, with 11 participants (4,54%), Level 3 with seven participants (2,89%), and finally Level 2 with two responses (0,82%). From a South African TVET context, this pattern suggests that students at the entry and mid-levels of the qualification system demonstrate a greater interest in engaging and continuing in mobile learning initiatives, perhaps due to being in the initial knowledge awareness stage. According to (DHET, 2022), the exit-level enrolment, such as N6, was lower than that of N5 and N4. This aligns well with the diminished participation in exit levels, such

as N6 and NCV Level 4, which may be linked to academic demands and diminished availability, as exit-level students typically concentrate on final examinations, practicals, work-integrated learning, or internships. Consequently, women still comprised a large number of exit-level students in business studies and across various TVET fields, reflecting why the dominant participants were predominantly female (Friderichs et al., 2024). This demonstrates why students enrolled in Report 191 Business Studies showed greater interest in responding to the survey than students in the NCV fields of study. Thus, it is important for HEIs in South Africa to create policies and strategies that aim to promote mobile learning awareness in the early stages of students' enrolment.

5.2.5 Participants' status of technology use

The aim of this study was to investigate the influence of using mobile learning applications on students at a South African HEI. As a result, it was significant that the study understood participants' perspectives towards using mobile technology in an academic environment. Table 5.5 summarises the participants' interaction with mobile technology initiatives.

Table 5.5: Participants' device utilisation (Source: SPSS 2024)

	Frequency	**Percent**
Smartphone	186	76,85
Tablet	9	3,71
Laptop	25	10,33
Desktop	19	7,85
Other	3	1,23

According to the Table 5.5, smartphones were the most widely used technology gadget with a dominance of 186 participants (76,85%), second was laptops with 25 participants (10,33%), and third was desktops with 19 responses contributing 7,85%, fourth was tablets with 9 participants (3,71%), and other technology gadgets with three responses and a rating of 1,23%. The dominance of smartphones has validated global and local trends in mobile learning adoption, especially in low-income countries, where cost-effectiveness and mobility enhance

utilisation (Criollo-C et al., 2021; Qazi et al., 2024). Students were regularly using smartphones for routine tasks and were increasingly incorporating them as tools for assessment and evaluation in digital remote education (Lazaro & Duart, 2023). Similarly, the adoption of mobile learning is significantly more visible among younger participants than among the older generation, due to the utilisation of smartphones and other digital tools in mobile learning applications, which is expected to rise both at home and when traveling (Lutfi et al., 2022). This study is based on the perspective that students' dependence on smartphones may be due to the relative advantage component of the tool, aligning well with the characteristics of the DOI theory. These students often appreciate the flexibility and accessibility of mobile learning through handheld smartphones. However, the complexity and compatibility (DOI theory components) of the technology may limit its ability to integrate into students' lifestyles (Acikgoz et al., 2023), and this may delay its adoption in academic settings.

5.2.6 Participants' source of connectivity

Mobile learning initiatives cannot completely thrive without the use of connectivity mechanisms. As a result, Table 5.6 of the study explored participants' responses regarding access to connectivity mechanisms while learning. A total of 141 participants (58,26%) noted the source of connectivity as school or college, with 84 participants (34,71%) having access to the internet at home. While 12 participants (4,95%) relied on a paid internet café as a source of connectivity, 2 participants (0,82%) connected at work, and 3 participants (1,23%) used other alternative mechanisms to connect to the internet. This means that participants must have a computer, a smartphone, and a reliable internet connection to utilise learning technology tools. Acquiring these technologies has proved costly, particularly in remote or disadvantaged regions (Criollo-C et al., 2021; Isman, 2023; Qazi et al., 2024). As such, the majority of students indicated that they relied on college-provided Wi-Fi, supporting the findings of a South African study by Mateko et al. (2025), which highlighted the significance of institutional infrastructure in facilitating mobile learning, especially in rural and resource-limited contexts such as the Vhembe District. This further demonstrates the digital inequalities between privileged and underprivileged students in South African HEIs (Mabidi, 2024). Therefore, without effective policies and strategies and in the absence of dependable institutional connectivity, mobile learning efforts may produce discriminatory consequences. This further underscores the necessity of recommendations by Landa et al. (2021) calling for governmental interventions

and public-private partnerships to enhance cheap internet access throughout South African HEIs.

Table 5.6: Participants' mode of connectivity (Source SPSS 2024)

Access to internet services	Frequency percentage (%)	
Home	84	34,71
Work	2	0,82%
School/ College	141	58,26%
Internet Café	12	4,95%
Other	3	1,23%

5.2.7 Participants' technology proficiency

The proficiency of students and educators in utilising several digital learning tools is crucial for the execution of digital learning platforms (Alyoussef, 2023). This is crucial, as it sometimes serves as a precondition for accepting and using mobile learning tools. Digital literacy involves the capacity to access, comprehend, assess, generate, and convey information through digital technology (Avinç & Doğan, 2024). For this study, 118 participants (48,76%) stated that they had good technology skills, followed by 61 participants (25,20%) with fair skills, and 24 participants (9,91%) reflected poor digital literacy skills. One user (0,41%) stated that they were a non-user of technology, 8 participants (3,30%) stated their status as intermediate, and 15 participants (6,19%) stated their status as beginners or advanced, respectively.

Table 5.7: Participants' technology skills level (Source SPSS 2024)

Technology skills level	Frequency	Percentage (%)
Poor	24	9,91%
Beginner	15	6,19%
Fair	61	25,20%
Good	118	48,76%
Intermediate	8	3,30%
Advanced	15	6,19%
Non-user	1	0,41%

Studies in mobile learning and digital transformation have yielded mixed opinions on students' digital or technology proficiency, ranging from basic smartphone interaction to more advanced interactions with HEI-adapted learning management systems. These studies revealed that an absence of technological skills promotes the perception that technology is challenging to utilise, hence lowering an individual's willingness to stay engaged in its use (Alturki & Aldraiweesh, 2022; Bucăţa et al., 2022; Goundar & Kumar, 2022; Lai et al., 2022). This is somewhat highlighted by the fact that fewer than 50% of participants possess good technology competency. Despite the slightly low percentage of technology competencies, this may highlight students' limited adoption, despite a high percentage in smartphone ownership. This aligns well with the findings of one study, which linked the direct effects of learning technology adoption on students' perceived ease of use (Alturki & Aldraiweesh, 2022).

Although most of the participants indicated having good technology skills, this might indicate adoption challenges due to varying technology skills, which is a problem for most South African HEIs. Scholars have emphasised the importance of obtaining a variety of 21st-century technological skills as a means to achieve success in the modern era, marked by swift and dynamic technological developments (Sari et al., 2022). This suggests that Vhembe TVET college students with poor or limited technology skills may contribute to underutilisation and hinder the efficient integration and utilisation of mobile learning technology in academic settings. The delay in incorporation may align well with the complexity and compatibility components of the DOI theory (Abdalla et al., 2024), where students with good technology skills perceive mobile technology as easy to incorporate and compatible with satisfying needs, compared to those with poor or low skills.

The following were additional responses noted by the researcher for three students who highlighted experiences with question number seven of the questionnaire (How do you consider your technology proficiency/skills level?). The responses yielded mixed results regarding how students assessed their technology proficiency.

Response 1 – “I am not sure of my skill level, but I use my smartphone for calls, chatting, and learning.”

Response 2 – “I consider my technology skills level to be good as I use my mobile devices for many things, such as Google, banking apps, social media, and Moodle for learning.”

Response 3 – "I do not have a suitable mobile device for engaging in activities that require the use of the internet. However, I am still learning the use of computers through the life orientation module."

The participants' demographic composition and technology skills levels indicate that the younger generation at Vhembe TVET college, dominated by female students, relies heavily on smartphones, possesses intermediate to good technology literacy, and is significantly dependent on institutional connectivity infrastructure. These contextual elements influence students' perceptions and interactions with mobile learning technologies, providing a crucial understanding of the patterns and behaviour of students discussed and analysed in the next sections.

5.3 PRELIMINARY TESTING OF VARIABLES.

5.3.1 MEASUREMENT MODEL: RELIABILITY AND VALIDITY

This part of the study highlights the measurement model, which is the technique used to determine whether the gathered data align effectively with the model employed and the hypotheses to be tested. The first part tested the validity and reliability of the different elements, and the second part assessed the alignment of the data with the chosen model. These included checking the associated elements of the DOI, which influenced students' attitudes towards utilising the mobile learning applications and the perceived risk of accepting these applications for learning in an academic environment, using a reliability coefficient. The Cronbach's alpha reliability coefficient result was 0,871, demonstrating a significant internal consistency for this study's measurement scale.

Table 5.8: Reliability statistics based on Cronbach's alpha (Source: SPSS 2024)

Cronbach's alpha (α)	**Cronbach's alpha (α) based on standardised items**	**Number of items**
0,871	0,871	29

5.3.2 VARIABLE DESCRIPTIVE STATISTICS

This study employed variable descriptive statistics to interpret the participants' level of agreement towards using mobile learning applications in HE environments, and most

importantly, the distribution of the dataset. The average minimum, maximum, means, and standard deviations of the different variables were used for interpretation. The mean signifies the central value of a numerical dataset. Table 5.9 illustrates the dispersion of the dataset relative to the mean, as measured by the standard deviation.

Table 5.9: Variable descriptive statistics (Source SPSS 2024)

Variable	Min	Max	Mean	Standard deviation
Relative advantage	1	5	3,28	1,219
Complexity	1	5	3,22	1,006
Compatibility	1	5	3,51	1,127
Observability	1	5	3,73	0,974
Trialability	1	5	3,65	0,984
Perceived risk	1	5	2,78	1,191
Attitude	1	5	3,59	1,111
Usage intention	1	5	3,70	1,053

The average minimum of the dataset is one (1), signifying the utmost degree of disagreement (Strongly Disagree), and the average maximum of the dataset is five (5), signifying the utmost degree of agreement (Strongly Agree). This indicates that out of the 242 participants who returned the questionnaire, there was at least one participant who strongly disagreed and one who strongly agreed with the effect of the DOI elements (relative advantage, complexity, compatibility, observability, trialability), attitude, and perceived risk influencing the usage of mobile learning in the HEI settings.

According to Table 5.9, the interpretation of the average mean value of 3,28 and the standard deviation of 1,219 signified a moderate agreement regarding the relative advantage of using mobile learning in academic environments. The complexity of using mobile learning tools was lower as indicated by an average mean value of 3,22 and a standard deviation of 1,006, representing a slight disagreement. Like the relative advantage, the compatibility of mobile learning tools was signified by a moderate agreement with an average mean of 3,51 and 1,127 standard deviations. The observability and trialability of mobile learning tools, which illustrate how participants easily understood mobile learning through visibility and trial, signified a high

level of agreement with mean values of 3,73 and 3,65 and standard deviations of 0,974 and 0,984, respectively.

The participants were also concerned about the perceived risk of using mobile learning tools in academic settings. As a result, this was indicated by an average low mean of 2,78 and a standard deviation of 1.191. However, these participants signified a favourable attitude and a higher intent to utilise mobile learning in academic settings. This was reflected by the average mean of 3,59 and 3,70, with a standard deviation of 1,111 and 1,053, in that order.

5.3.3. SCALE RELIABILITY ANALYSIS

The study also performed a reliability evaluation of the scales used for the descriptive statistics. Reliability coefficients aim to measure the ratio of systematic variance to overall variation, providing values between 0 and 1, with higher (not approaching one), although not too high values being acceptable (Doval, Viladrich & Angulo-Brunet, 2023). This evaluation is crucial for confirming that the measurement instrument contains the necessary items with significant representational strength, rather than unnecessary ones (Avinç & Doğan, 2024). Reliability evaluation assesses the stability of an instrument to ensure its dependability and consistency throughout subsequent measurements (Erlinawati & Muslimah, 2021). As a result, the intended objective of the scale was to assess the suitability of each item in terms of its ability to deliver the desired data results. Table 5.10 summarises the scale reliability analysis using Cronbach's alpha with data generated from SPSS.

Item-total statistics

Table 5.10: Reliability evaluation item-total statistics (Source SPSS 2024)

*CLM 1 = Scale Mean if Item Deleted, CLM 2 = Scale Variance if Item Deleted, CLM 3 = Corrected Item-Total Correlation, CLM 4 = Squared Multiple Correlation, CLM 5 = Cronbach's Alpha if Item Deleted.

	CLM 1	CLM 2	CLM 3	CLM 4	CLM 5
Relative Advantage 1	96,26	198,444	0,649	0,643	0,860
Relative Advantage 2	96,34	196,716	0,679	0,757	0,859
Relative Advantage 3	96,22	197,989	0,655	0,683	0,860
Relative Advantage 4	96,01	197,676	0,612	0,658	0,861

Relative Advantage 5	96,33	199,318	0,628	0,571	0,861
Relative Advantage 6	96,14	196,199	0,664	0,647	0,859
Complexity 1	95,64	214,049	0,277	0,420	0,870
Complexity 2	95,77	214,400	0,219	0,432	0,871
Complexity 3	96,77	223,554	-0,101	0,430	0,879
Complexity 4	97,34	229,163	-0,265	0,460	0,883
Compatibility 1	95,91	199,220	0,708	0,672	0,859
Compatibility 2	96,07	204,452	0,519	0,498	0,864
Compatibility 3	96,29	199,312	0,576	0,528	0,862
Observability 1	95,78	211,145	0,370	0,406	0,868
Observability 2	96,02	203,356	0,565	0,584	0,863
Observability 3	95,81	205,565	0,526	0,529	0,864
Trialability 1	95,75	214,602	0,258	0,253	0,870
Trialability 2	96,23	215,604	0,127	0,413	0,874
Trialability 3	95,88	215,362	0,183	0,412	0,872
Perceived Risk 1	97,07	226,331	-0,181	0,562	0,882
Perceived Risk 2	96,54	221,693	-0,048	0,466	0,879
Perceived Risk 3	96,84	225,480	-0,151	0,478	0,882
Attitude 1	96,02	201,352	0,629	0,666	0,861
Attitude 2	95,94	199,955	0,665	0,671	0,860
Attitude 3	95,99	198,498	0,672	0,720	0,860
Attitude 4	96,10	199,630	0,621	0,721	0,861
Usage Intention 1	96,01	201,129	0,646	0,661	0,861
Usage Intention 2	95,87	202,096	0,605	0,673	0,862
Usage Intention 3	95,83	201,040	0,646	0,697	0,861

According to Table 5.10, the interpretation of CLM 5 (the Cronbach's alpha if Item Deleted) signifies a good internal consistency on all items measured. Thus, the reliability coefficient value of the result between 0,8 and 0,9 demonstrated a good or significant degree of internal consistency for this study's measurement scale. Moreover, most variables or items measured in all columns had consistent results or values.

CLM 3 (Corrected Item-Total Correlation) also indicated the strength of the performance results of other variables, which had a value above 0,6. For example, all items under relative advantage, attitude, usage intention, and compatibility 1. These items' item-total correlation substantially contributes to and demonstrates good internal consistency. However, some highlighted items, represented by a negative value, demonstrated an unfavourable correlation, which posed a problem to the overall reliability test. These variables with negative or lower consistency were complexity levels 3 & 4, trialability level 2, and perceived risk levels 1, 2, and 3. This study recognised that participants may have varying knowledge, opinions, or understanding of the measured elements or variables, which could lead to unfavourable correlations. Therefore, to limit inconsistency, the study removed these variables or items to see if the results would still indicate good internal consistency.

During the process of removing problematic items that were not good for internal consistency, the following results were found:

- The Cronbach's alpha increased to 0,936, which is still acceptable, as it was below the high of 0,95. Moreover, the Cronbach's alpha if Item Deleted falls between 0,930 to 0,938 on all items, which is excellent for internal consistency.
- Relative advantage – All six items under the relative advantage element fell between 0,930 to 0,932 (Cronbach's alpha if Item Deleted) and 0,653 to 0,746 (Corrected Item-Total Correlation). These items contribute positively to good internal consistency.
- Complexity – Complexity 3 and 4 were removed, leaving only Complexity 1 and 2. Although both show a lower correlation between them (0,229 & 0,138), the Cronbach's alpha if Item Deleted was still well within an acceptable value range of 0,938 to 0,940. The remaining complexity items were not removed during this stage.
- Compatibility – All three compatibility items were not removed as the Corrected Item-Total Correlation fell between 0,550 and 0,752, while the Cronbach's alpha if Item

Deleted was acceptable between 0,931 and 0,934. Compatibility 2 had a weaker correlation than the rest, but still acceptable considering a higher Cronbach's alpha.

- Observability – The correlation on Observability 1 was very low, as it was on 0,366 with the other two on 0,552 and 0,597, respectively. However, the Cronbach's alpha if Item Deleted ranged between 0,933 to 0,936, which was still excellent for internal consistency. The item was maintained for further analysis.
- Trialability – The only item remaining under this category was Trialability 1, which had a low correlation of 0,184 and a Cronbach's alpha if Item Deleted of 0,938. This item was removed from the analysis as it could not improve the reliability scale alone.
- Attitude – All three attitude items demonstrated a strong correlation and had an excellent Cronbach's alpha if the item was deleted between 0,930 to 0,931. The Corrected Item-Total Correlation ranged between 0,709 to 0,763.
- Perceived risk – Perceived Risk 1, 2, and 3 were removed due to negative correlation and could not improve the reliability scale. The Corrected Item-Total correlations were -0,181, -0,048, and -0,151 for Perceived Risk 1, 2, and 3, respectively.
- Usage intention – Similar to attitude items, all items under the usage intention category demonstrated a good performance on the reliability scale. These items had a strong correlation between 0,669 and 0,707, and Cronbach's alpha ranged from 0,931 to 0,932.

5.3.4. THE EXPLORATORY FACTOR ANALYSIS

This study conducted an Exploratory Factor Analysis (EFA) to determine the sample's appropriateness and evaluate the factorability of the correlation matrix. The EFA was considered a multivariate statistical technique designed to clarify the links among a collection of determined variables through the analysis of a reduced number of unobservable (latent) variables known as factors (Ledesma, Ferrando, Trogollo, Poo, Tosi & Castro, 2021). It determines the foundational framework related to a collection of metrics by recognising emergent latent factors (Howard & Henderson, 2023). The EFA is commonly employed in the development of scales and validity investigations, as well as to authenticate a predetermined construct (Acar GüvendiR & Özer Özkan, 2022). Therefore, this tool helped to assess the foundational framework, develop a scale, and investigate the validity of this mobile learning study in the HE sector.

Factor assumption testing

Before the EFA assessment, the first step was to remove problematic items, such as Complexity 1 and 2, that had not been removed in the previous stage. Only 19 items formed part of the EFA analysis and were used to ascertain the fundamental factor structure associated with mobile technology adoption elements. The initial phase of testing our assumptions revealed the following results related to the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity. According to the KMO, the coefficient results indicated that the sampling adequacy was 0.940. This is viewed as adequate (Shrestha, 2021), indicating that the sample size and data structure were suitable for factor analysis. The Bartlett's Test of Sphericity, depicted by a chi-square formula was $\chi 2$ (406) = 3982,89, $p<0,001$, which suggested sufficiency of items for factor analysis and good correlation between items. Moreover, the Measures of Sampling Adequacy (MSA) further support the appropriateness of each item for consideration in factor analysis. This is because all the individual items' values on the Anti-Image Correlation Matrix were above 0,90, ranging between 0,845 and 0,957.

Factor extraction communalities

All the items had acceptable communalities values above 0,40, with the majority above 0,60 (at least 17 items). These results mean that the extracted factors explain a large enough part of each item's variation. The only items below the 0,60 communalities value were between 0,416 for Compatibility 2 (Moderate) and 0,480 for Compatibility 3 (low). Thus, the structure of the components is fitting and clear, which supports the construct validity of this study scale.

Table 5.11: Communalities table based on Principal Component Analysis Extraction Method (Source SPSS 2024).

Relative Advantage 1	1,000	0,638
Relative Advantage 2	1,000	0,770
Relative Advantage 3	1,000	0,706
Relative Advantage 4	1,000	0,689
Relative Advantage 5	1,000	0,611
Relative Advantage 6	1,000	0,656
Compatibility 1	1,000	0,645

Compatibility 2	1,000	0,416
Compatibility 3	1,000	0,480
Observability 1	1,000	0,751
Observability 2	1,000	0,707
Observability 3	1,000	0,656
Attitude 1	1,000	0,650
Attitude 2	1,000	0,674
Attitude 3	1,000	0,740
Attitude 4	1,000	0,753
Usage Intention 1	1,000	0,652
Usage Intention 2	1,000	0,697
Usage Intention 3	1,000	0,676

Factor extraction and rotation results

The study then conducted the EFA analysis test based on the factor extraction and rotation to determine whether the factors were related. The factor extraction was based on principal components using Kaiser's (Eigenvalue) Criterion, Scree plot (Shrestha, 2021), and the factor rotation was based on the Promax factor analysis method. The factor extraction revealed three factors and an Eigenvalue greater than 1, which is also supported by the results of the scree plot. The factor correlation matrix showed that the components had a mixture of moderately correlated to strongly correlated. For example, the Promax factor analysis results for Factor 1 and Factor 2 suggested a close correlation between the factors, with a value of 0,719. Factor 1 and Factor 3 had a value of 0,512, suggesting a moderate correlation between the factors, while Factor 2 and Factor 3 assumed a value of 0,610, suggesting a strong relationship.

Table 5.11 shows how much each item contributed to each factor. Items with values lower than 0,50 were hidden, leaving only items with greater values. The interpretation of the three factors was as follows:

- Factor 1 – These are factors related to mobile technologies' innovation perception (or performance perception) in the HE academic environment. These items relate to the relative advantage and compatibility of the technology.
- Factor 2 – These are factors related to the attitude and usage intention of users (students) in using mobile learning technology in HE.
- Factor 3 – This factor is related to the visibility of mobile learning technology in the HE academic settings. It relates to the students' ability to observe technology.

Table 5.12: Factor correlation matrix (Source SPSS 2024)

	Factor 1	**Factor 2**	**Factor 3**
Factor 1	1,000	0,719	0,512
Factor 2	0,719	1,000	0,610
Factor 3	0,512	0,610	1,000

The factor pattern matrix

The interpretation of the pattern matrix reflects that Factor 1 grouped items (relative advantage and compatibility) reflected the users' perceived technology advantage relating to its benefits, performance, usefulness, and compatibility. Moreover, the technology is considered fit for academic purposes, and higher item values support this. For example, relative advantage items 1 to 6 ranged from 0,740 to 0,890, compatibility items 1 to 3 ranged from 0,582 to 0,611.

Secondly, Factor 2, which grouped items (attitude and usage intention), reflects the user's positive attitude and change in behavioural intention towards the utilisation of mobile technologies in academic settings. This was supported by higher values on attitude items 1 to 4, which ranged between 0,733 to 0,895, and usage intention items 1 to 3, which ranged between 0,747 to 0,913.

Lastly, Factor 3 only includes observability items, which interpret the user's perceived visibility of the technology. It can include how the technology is socially communicated in the education system. This was backed by observability items 1 to 3 with higher values ranging between 0,655 to 0,950.

Table 5.13: Factor pattern matrix (Source SPSS 2024)

	Component		
	1	**2**	**3**
Relative Advantage 1	0,740		
Relative Advantage 2	0,890		
Relative Advantage 3	0,864		
Relative Advantage 4	0,886		
Relative Advantage 5	0,819		
Relative Advantage 6	0,753		
Compatibility 1	0,611		
Compatibility 2	0,605		
Compatibility 3	0,582		
Observability 1			0,950
Observability 2			0,724
Observability 3			0,655
Attitude 1		0,733	
Attitude 2		0,786	
Attitude 3		0,797	
Attitude 4		0,895	
Usage Intention 1		0,747	
Usage Intention 2		0,913	
Usage Intention 3		0,795	

Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalisation

Overall, the EFA results support the three-factor structure and suggest further analysis to ensure that the results align with what theory predicts should happen. The matrix combined the relative advantage and compatibility items under one factor, suggesting that users (students) have a wide range of ideas about how mobile learning technology can support them in their academic activities. Secondly, merging attitude and usage intention into a single factor revealed that users' positive opinions were closely linked to their intended actions. Observability was identified as a separate factor, highlighting its unique impact on decisions to adopt mobile technology based on what users have observed or seen.

5.3.5. THE CORRELATION ANALYSIS

Identifying Significant Predictors

A Pearson correlation analysis was employed to examine the interconnection between the most significant elements in the conceptual model. These elements were significant in predicting the usage intentions of mobile learning, which was mediated by students' attitudes in academic settings. The Pearson correlation coefficient is the most commonly employed and acknowledged metric by researchers and scientists for evaluating the linear relationship between two variables(Temizhan, Mirtagioglu & Mendes, 2022). The process was conducted using the mean variable of the remaining elements that were not eliminated in the previous analytical steps. Table 5.14. highlights the correlation between these significant variables:

Table 5.14. Pearson correlation coefficient of variables (source SPSS 2024)

	RA_mean	**CB_mean**	**OV_mean**	**AT_mean**	**UI_mean**
RA_mean Pearson Correlation	1	,733**	,457**	,676**	,602**
Sig. (2-tailed)		<,001	<,001	<,001	<,001
N	242	242	242	242	242
CB_mean Pearson Correlation	,733**	1	,476**	,645**	,605**
Sig. (2-tailed)	<,001		<,001	<,001	<,001
N	242	242	242	242	242
OV_mean Pearson Correlation	,457**	,476**	1	,523**	,541**

Sig. (2-tailed)	<,001	<,001		<,001	<,001
N	242	242	242	242	242
AT_mean Pearson Correlation	,676**	,645**	,523**	1	,780**
Sig. (2-tailed)	<,001	<,001	<,001		<,001
N	242	242	242	242	242
UI_mean Pearson Correlation	,602**	,605**	,541**	,780**	1
Sig. (2-tailed)	<,001	<,001	<,001	<,001	
N	242	242	242	242	242

** Correlation is significant at the 0.01 level (2-tailed).

Notes: RA_mean = Relative Advantage, CB_mean = Compatibility, OV_mean = Observability, AT_mean = Attitude, UI_mean = Usage Intention

From the Pearson correlation coefficients (r) and significance levels (p-values), significant predictors with strong correlations were identified using Cohen's guidelines (Schober, Vetter & Mascha, 2021). These were interpreted as follows:

- All correlations reflect the statistical significance at $p < 0{,}001$ and positive ranging from moderate to very strong. For example, this signifies that as one variable escalates, the other typically increases concurrently,

The variables with the strongest correlation that were deemed significant to influence students' usage intention were identified as:

- Attitude ($r = 0.780$, $p < 0.001$) reflecting a very strong correlation.
- Compatibility ($r = 0.605$, $p < 0.001$) reflecting a moderate correlation.
- Relative advantage ($r = 0.602$, $p < 0.001$) reflecting a moderate correlation.
- observability ($r = 0.541$, $p < 0.001$) reflecting a moderate correlation.

The variables with the strongest correlation that were deemed significant to influence students' attitudes were identified as:

- Relative advantage ($r = 0.676$ $p < 0.001$) reflecting a moderate correlation.

- Compatibility ($r = 0.645$, $p < 0.001$) reflecting a moderate correlation.
- observability ($r = 0.523$, $p < 0.001$) reflecting a moderate correlation.

Therefore, this provides a clear indication that students' attitudes and usage intentions have a significant relationship with the relative advantage, compatibility, and observability of the technology. The strong relationship between relative advantage and compatibility ($r = 0.733$, $p < 0.001$) might suggest that students see these elements as psychologically related.

Multiple Regression Model

A multiple regression analysis was employed to assess whether usage intention could be predicted by elements such as relative advantage, compatibility, observability, and attitude. The model was interpreted as follows:

Table 5.15. The multicollinearity results table (Source: SPSS 2024)

	Unstandardised Coefficients					Collinearity statistics	
Model	β	Std. Error	Standardised Coefficient beta (β)	t	Sig	Tolerance	VIF
Constant	,458	,184		2,494	,013		
RA_mean	,042	,057	,047	,750	,454	,390	2,562
CB_mean	,113	,060	,113	1,877	,062	,412	2,427
OV_mean	,179	,054	,155	3,327	,001	,691	1,447
AT_mean	,566	,055	,594	10,351	<,001	,457	2,190

Firstly, the multicollinearity diagnostics revealed acceptable levels of Variance Inflation Factor (VIF) and tolerance levels. Multicollinearity is not an issue in the data, as all variables exhibit tolerance values above 0,1 and VIF values below 5 (Yıldırım, 2024). The acceptable values of VIF and tolerance were: Relative advantage (2,562 & ,390), Compatibility (2,427 & 0,412) and Attitude (2,190 & 0,457). The observability diagnostic revealed a very low risk with a VIF of

1,447 and a tolerance of 0,691. This study is based on the perspective that the presence of attitude as a mediator may have influenced the low results. Therefore, the above results confirm that there is no evidence of problematic multicollinearity among the predictors. All the VIF values are below 3, and all tolerance values exceed 0.20, indicating that the predictors are not highly correlated with one another.

Secondly, the regression coefficient standardised values (β) and significance levels (Sig.) were interpreted as follows: relative advantage and compatibility were not significant predictors of usage intention with β = 0,047: Sig. = 0,454 & β = 0,113: Sig. = 0,062, respectively. Observability highlighted a strong prediction with β = 0,155: Sig. = 0,001. The strongest predictor of usage intention was attitude, with β = 0,594: Sig. = <0,001. This aligns somewhat well with the Pearson correlation coefficients (r) and significance levels (p-values) obtained in the previous section. Therefore, this pattern supports a mediation analysis, allowing the study to confirm whether relative advantage and compatibility have an indirect influence on usage intention through the mediation of attitude. The mediation analysis is presented in the following sections after testing the hypothesis.

5.3.6 REGRESSION ANALYSIS: HYPOTHESIS TESTING

The next segment of the research aimed to examine the hypotheses related to the validated factors. However, the reliability and EFA analyses highlighted the necessity to exclude numerous factor items that demonstrated low factor loadings or compromised the internal consistency of their respective variable. This cleaning method ensured that only the reliable factors were retained to represent each variable and were evaluated using the final, validated measured items. Any hypotheses that included components or items eliminated throughout the measurement refinement process were removed from the final testing process, although the original conceptual model remained theoretically grounded. Moreover, this modification does not affect the theoretical purpose of this study; rather, it guarantees that the overall results are derived from factors with strong reliability and validity. As a result, this process helped to enhance the credibility of the findings.

According to Table 5.16, when other factors are considered, the relative advantage factor imposes no substantial impact on usage intention. This is highlighted by the significance values (p = 0,454 > 0,05) indicating a lack of support for the H1 hypothesis. This suggests that students don't choose to use mobile learning because they believe it's not as effective as other learning

methods. One probable reason is that students already use mobile learning technologies for other purposes in academic settings and might not see it as a new tool that offers evident benefits. This study suggests that HEIs must develop strategies that promote the utilisation of mobile learning, thereby changing students' attitudes rather than focusing merely on the technology's relative advantages.

Table 5.16: Hypothesis testing results

Hypothesis	**Path**	**Unstandardised Coefficient (β)**	**t-value**	**p-value**	**Support Decision**
H1	Relative Advantage → Usage Intention	0,042	0,750	0,454	No
H3	Compatibility → Usage Intention	0,113	1,877	0.062	No
H5	Observability → Usage Intention	0,179	3,327	0,001	Yes
H7	Attitude → Usage Intention	0,566	10,351	<0,001	Yes

Hypothesis	**Path**	**Direct effect (β)**	**P-value**	**Indirect effect**	**95% CI (Indirect)**	**Support Decision**
H8	Attitude → Relative advantage→Usage Intention	0,1257	0,0116	0,4225	0,0116	Yes (Partial)
H10	Attitude→Compatibility →Usage Intention	0,1736	0,0009	0,4299	0,0009	Yes (Partial)
H12	Attitude→Observability →Usage Intention	0,2116	0,0001	0,4123	0,0001	Yes (Partial)

Compatibility is not statistically significant but favourable; however, it has a weak effect on usage intention with values (p = 0,062). This H3 hypothesis is not supported at a 0,05 level. This suggests that the extent to which mobile learning tools align with students' established

learning styles, experiences, or individual preferences may not be a significant determinant of individual intent to use mobile learning technologies in academic settings.

The significance of observability was highlighted as having a positive effect on usage intention with values ($p = 0.001$, $p < 0.05$). This means that the H5 hypothesis is supported, as Students are encouraged to utilise mobile learning when they can see and evaluate the system's results.

The most effective and significant predictor of usage intention was the attitude factor, with a value of ($p < 0.001$). According to the above table, the H7 hypothesis was completely supported. This suggests that students who demonstrate a more positive attitude towards mobile learning are significantly more likely to utilise it in academic settings. These results demonstrated the importance of students' perceptions of technology innovation in influencing mobile technology adoption behaviour.

Mediation hypothesis

Although the mediation analysis is fully explained in the next section, three hypotheses were tested to verify whether the mediation was supported. After incorporating attitude as the mediator, the relative advantage factor demonstrated a strong prediction capacity to attitude with values ($\beta = 0{,}6457$, $p = 0{,}0000$). Meanwhile, the attitude factor was a strong predictor of usage intention ($\beta = 0{,}6543$, $p = 0{,}0000$). Secondly, when validating the indirect effect, the relative advantage on usage intention mediated by attitude was $\beta = 0{,}4225$, BootSE = 0,0537, with a 95% confidence interval of [0,3209: 0,5324]. The absence of zero in the confidence interval indicates that there was considerable mediation. However, the direct effect of relative advantage on usage intention continued to be significant even though the values were reduced to ($\beta = 0{,}1257$, $p = 0{,}0116$). Therefore, this is a validation for partial mediation and support for the H8 hypothesis. This confirms that the attitude only partly explains how the relative advantage of the technology affects students' intention to accept and utilise mobile learning technology.

The compatibility factor demonstrated a strong predictive relationship with attitude indicated by values ($\beta = 0{,}6756$, $p = 0{,}0000$). Again, the attitude factor was a strong predictor of usage intention, indicated by the values ($\beta = 0{,}6363$, $p = 0{,}0000$). The indirect effect of compatibility on usage intention mediated by the attitude factor was $\beta = 0{,}4299$, BootSE = 0,0632, with a 95% confidence interval of [0,3111: 0,5614]. These values signify the existence of substantial mediation. The direct effect indicated partial mediation that remained significant ($\beta = 0{,}1736$,

p = 0,0009). This suggests that the attitude factor partially mediates the influence of compatibility on students' willingness to use mobile learning technologies in academic settings, partly supporting the H10 hypothesis.

Lastly, the observability factor demonstrated a meaningful predictive capacity for attitude as indicated by values (β = 0,6326, p = 0,0000). Similar to the previous two factors mediated by attitude, it remained a strong predictor of usage intention (β = 0,6519, p = 0,0000). The indirect effect of observability on usage intention through attitude mediation was signified by a value of β = 0,4123, BootSE = 0,0616, with a 95% confidence interval of [0,2950: 0,5358]. This is significant due to the absence of zero in the confidence interval. Again, the direct effect is significant, as demonstrated by the value (β = 0,2116, p = 0,0001). All these effects validate partial mediation and support the H12 hypothesis, which indicates that attitude serves as a partial mediator between observability and usage intention.

5.3.7. CONTROL VARIABLE EFFECT AND JUSTIFICATION.

This study's conceptual model illustrated control variables, including age, gender, and level of education, with relevant information available on the questionnaire. However, these demographic contextual variables were only identified in the conceptual model, without any original hypotheses being formulated. These factors were included for statistical analysis and theory enhancement, without evaluating their impact on other variables. This study theoretically examines the grounded relationships among the fundamental factors originating from the DOI and other technology acceptance models. This study considered factors with theoretical foundations to keep the model simple and uncomplicated, and to avoid using control variables that might obscure the true effects of the essential variables. Consequently, only the original proposed hypotheses were examined to achieve simplicity, clarity, focus, and theoretical integrity in the investigation.

5.4 MEDIATION ANALYSIS

Mediation analysis (Process Macro for SPSS).

A mediation analysis study was performed utilising Hayes PROCESS macro Model 4 for SPSS (Clement & Bradley-Garcia, 2022). This was ideal for investigating whether attitude mediates the influence of relative advantage, compatibility, and observability on usage intention. Mediation analysis is utilised when a researcher seeks to understand, elaborate, or assess a

hypothesis regarding the process or mechanism via which variable X affects Y, with a mediator variable (M) causally positioned between X and Y, functioning as the conduit through which X impacts Y (Igartua & Hayes, 2021). This process was conducted separately for each independent variable. The variables were described as follows: X = Relative advantage, Compatibility, and Observability, Y = Usage Intention, and M = Attitude.

Part 1. Relative advantage→ attitude→ usage intention mediation analysis.

Table 5.17. The summary of the findings where X = relative advantage. (Source: SPSS 2024)

Mediation path	Mediation effect β	SE	P	95%CI	Significance level Status
Relative Advantage → Attitude.	0,6457	0.0454	0,0000	0,5563: 0,7352	Significant
Attitude → Usage intention.	0,6543	0,0517	0,0000	0,5524: 0,7561	Significant
Relative advantage → Usage intention (overall effect)	0,5482	0,0469	0,0000	0,4558: 0,6406	Significant
Direct effect	0,1257	0,0494	0,0116	0,0284: 0,2229	Significant (restricted)
Indirect effect	0,4225	0,0537		0,3209: 0,5324	Significant

The first step of the process revealed the following results, as depicted in Table 5.17. The results indicated that relative advantage was a substantial predictor of attitude, β = 0,6457, SE = 0,0454, and p = 0,0000. When the attitude factor was introduced, it was a significant predictor of usage intention, where β = 0,6543. SE = 0,0517 & p = 0,0000. The overall total impact of relative advantage on usage intention was substantial, β = 0,5482. SE = 0,0469, and p = 0,000. The direct effect appears to be lower; however, it remained significant after adjusting for attitude, β = 0.1257, SE = 0.0494, and p = 0.0116, suggesting restricted mediation. The indirect effect through attitude was significant, with a coefficient value of β = 0,4225, while confidence intervals at 95% were 0,3209: 0,5324. These findings therefore suggest that students perceive technology's relative advantage as both attitude-enhancing and improving usage intention.

Part 2. Compatibility → attitude→ usage intention mediation analysis.

Table 5.18. The summary of the findings where X = Compatibility. (Source: SPSS 2024)

Mediation path	Mediation effect β	SE	P	95%CI	Significance level Status
Compatibility → Attitude.	0,6756	0,0517	0,0000	0,5738: 0,7773	Significant
Attitude → Usage intention.	0,6363	0,0494	0,0000	0,5391: 0,7336	Significant
Compatibility → Usage intention (overall effect)	0,6035	0,0513	0,0000	0,5024: 0,7046	Significant
Direct effect	0,1736	0,0517	0,0009	0,0718: 0,2755	Significant (restricted)
Indirect effect	0,4299	0,0632		0,3111: 0,5614	Significant

Table 5.18 presents the summarized results when the X value represents compatibility. Compatibility had a substantial overall effect on usage intention, as reflected by the coefficient value β = 0,6035. SE = 0,0513, and p = 0,0000. When the attitude factor was incorporated as a mediator, the direct and indirect effects of compatibility on usage intention; the direct effect was reduced, and the coefficient values were β = 0,1736, SE = 0,0517, and p = 0,0009. However, the indirect effect was reflected as significant with β = 0,4299, and confidence intervals at 95% were reflected as 0,3209: 0,5324, serving as an indication of a strong mediation effect. This means that the attitude factor partly mediates the effect of compatibility on usage intention, allowing us to conclude that students who think mobile technology is more compatible are more likely to have good attitudes, which makes them more likely to adopt and use in academic settings.

Part 3. Observability → attitude→ usage intention mediation analysis.

Table 5.19. The summary of the findings where X = Observability. (Source: SPSS 2024)

Mediation path	Mediation effect β	SE	P	95%CI	Significance level Status
Observability → Attitude.	0,6326	0,0666	0,0000	0,5014:0,7637	Significant
Attitude → Usage intention.	0,6519	0.0439	0,0000	0,5655:0,7382	Significant
Observability → Usage intention (Overall effect)	0.6240	0.0626	0,0000	0,5006: 0,7473	Significant
Direct effect	0.2116	0.0531	0,0001	0,1071: 0,3161	Significant
Indirect effect	0,4123	0,0616		0,2950: 0,5358	Significant

According to Table 5.19, there was a significant effect on usage intention through observability, with coefficient values of β = 0,6240, SE = 0,0626, and p = 0.0000. The introduction of mediation through attitude to highlight the direct and indirect effects revealed that the direct effect of observability on usage intention was reduced with β = 0,2116, SE = 0,0531, p = 0.0001. However, the coefficient value β = 0,4123 and confidence intervals at 95% (0.2950, 0.5358) highlighted the indirect effect through the attitude factor. Moreover, the SPSS process macro results indicated that the standardised indirect effect was 0,3575 (BootSE = 0,0499), and confidence intervals at 95% (0,2595: 0,4538). These results indicate that the mediation effect ranged from moderate to strong, as attitude is considered a partial mediator between observability and usage intention. Therefore, in line with the mediation results, students were likely to have a more positive attitude about using mobile technology when they could see its benefits firsthand and hear about them from others. This aligns with the role of observability, which helps people understand how the technology works and the benefits it offers. This changes individual attitude, making it more likely to utilise the technology.

Mediation comparison summary,

The results from the SPSS Process macro indicated that both the relative advantage, compatibility, and observability have a substantial effect on usage intention. This effect was indicated both directly and indirectly through the attitude factor as a mediator. From all the tested instances, the level of mediation significance is partial, as each independent variable still has a slight and meaningful direct influence on usage intention, even when mediated by attitude. Observability has a slightly greater total influence than the other two, followed by compatibility. However, attitude continued to be a significant mediator in explaining why students want to adopt and use mobile learning technology.

5.5. THE PATH ANALYSIS.

The study performed a path analysis and drew a model to further examine how the different factors were related and affected each other. Path analysis is a method utilised for structural equation modelling (Gunuc, 2023). It is a statistical method utilised to examine causal relationships and the direct or indirect effects of several variables (Sun, Wu, Yao, Chiang & Lu, 2022). As such, the rationale for selecting path analysis is its capacity to extend beyond regression; it is an advancement of multiple regression that permits the examination of numerous final dependent variables, where one variable affects another, which subsequently influences a third variable (Prasad, 2022). In this study, the researcher utilised DOI elements (relative advantage, compatibility, and observability) mediated by attitude and how they influence students' intentions to adopt and use mobile technology in HE.

After the results from the EFA analysis, three grouped factors remained. These three factors relate to the innovation perception (relative advantage + compatibility), observability and response in behaviour (attitude + usage intention). Hence, the model was built on these three-factor components, which were identified through EFA analysis: innovation perception (IP), observability (OB), and response to behaviour (RB). Moreover, these factors were investigated using a theoretical approach of the DOI framework. This theory was also used in integrating technology in HE practices and learning methodologies, suggesting that adequate faculty training motivates them to utilise technology as an academic tool (Fahad & Shahid, 2022). The theory illustrates how innovations are adopted and disseminated within social systems, particularly focusing on the relationship between entities and new and established technologies

(Abdalla et al., 2024). Thus, how students see the properties of new innovative technologies and how easily it can be used affect how likely the technology is to be adopted.

Table 5.20: Factor correlation matrix with standardised coefficients

	IP (Factor 1)	**RB (Factor 2)**	**OB (Factor 3)**
IP (Factor 1)	1,000	0,719	0,512
RB (Factor 2)	0,719	1,000	0,610
OB (Factor 3)	0,512	0,610	1,000

Reporting the path analysis results through standardised coefficients (β)

To estimate the direct and indirect effects, the path analysis coefficient results were calculated as follows: The direction of the arrow shows a direct cause between each factor. For example, by keeping all else constant, it can be said that if IP goes up by 1 standard deviation, RB will go up by 0,50 standard deviations, which suggests that β = 0,50. Thus, from Table 5.14, the standardised regression weights were estimated and summarised:

- A direct influence was illustrated by a 0,50 coefficient (IP → RB).
- A beneficial and direct influence illustrated by a 0,42 coefficient (OB -> RB).
- An indirect influence illustrated by a 0,51coefficient value (IP → OB). Thus, this indirect influence of IP on RB is 0,51 multiplied by 0,42, which is about 0,21.
- Thus, the sum of the direct and indirect effects means that the standardised coefficients were illustrated by a total value of 0,71 (IP → RB) and calculated by adding 0,51 and 0,21, which equals 0,71.

Overall, the illustration of the path analysis model shows the existence of a direct influence from IP to RB, a direct influence from OB to RB and an indirect influence from IP to RB through OB as a third factor. The correlations show that both the IP and OB are strong predictors of RB. The IP influences RB directly and indirectly, and the total influence is considerable. Hence, students are more likely to embrace mobile technology innovation (RB) directly when users think it is functional and compatible with the academic operations (IP). These students were more likely to adopt it indirectly, by seeing others utilising it or noting its benefits through

its visibility within the HE campus (OB). In general, the perception and observation of mobile technology innovation are potent predictors of students' behavioural usage intention of the technology.

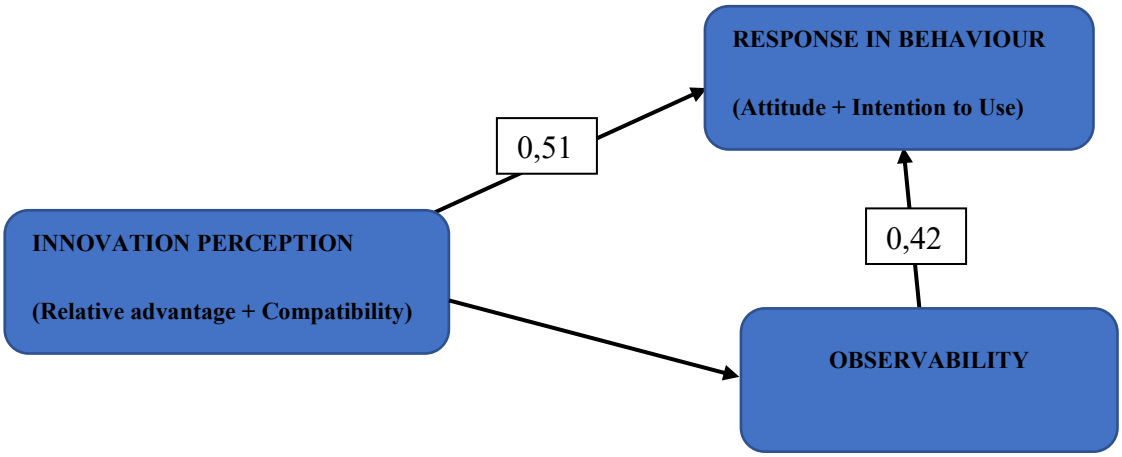


Figure 13: The path analysis model with standardised coefficients

5.6. THE MODEL FIT INDICES

Several fit indices are employed in structural equation modelling to check how well the models fit the study. There are eight commonly employed indicators that can assess the model's fit, including the chi-square to degrees of freedom ratio (χ^2/df), the goodness of fit index (GFI), the adjusted goodness of fit index (AGFI), the comparative fit index (CFI), the Tucker–Lewis index (TLI), the root mean square error of approximation (RMSEA), the standardised root mean square residual (SRMR), and the normative fit index (NFI) (Szilagyi, Cioca, Bacali, Lakatos & Birgovan, 2022). This study looked at five fit indices, and the results were as follows: (χ^2(df) = [value], $p < 0{,}001$), (CFI = 95, TLI = 94), (RMSEA = 0,05 (90% CI [.04, .06])), and (SRMR = 0,04). The chi-square showed promising results. The estimated p-value test for all inventories and subscales is below 0,05, demonstrating that the data is evenly distributed (Heydarnejad, Fatemi & Ghonsooly, 2022). RMSEA assesses the appropriate level of model fit to the data, taking into account model complexity and sample size (Sathyanarayana & Mohanasundaram, 2024). Values ranging from 0.08 to 0.10 are appropriate, whereas values below 0.05 signify a solid fit (Szilagyi et al., 2022). Thus, these results confirmed that the model fitted the study well.

5.7. ASSUMPTION CHECKS.

STEP 1

The first step of the assumption checks was conducted through the SPSS linearity assumption test. Simple scatterplots were created to compare each independent variable, defined including the relative advantage, compatibility, observability, and attitude, with usage intention as the dependent variable. The correlation results from the scatter plots revealed that the relationship between the variables seemed to be mostly linear, with no signs of curved or nonlinear patterns. However, the relative advantage and compatibility scatterplots indicated a spread of mild positive patterns, which is consistent with the factors ' earlier nonsignificant regression results. A positive linear correlation was observed between observability and the intention to use. Meanwhile, the most significant linear association was observed in terms of attitude, suggesting a strong correlation with usage intention. Therefore, the results from the scatterplots of all factors demonstrate that the linearity assumption tests were true for all independent variables.

STEP 2

The second step of the assumption tests was to conduct the normality residual assumption. This process employed both statistical and graphical approaches to verify the assumption that the residuals were normally distributed. The normality tests included the Kolmogorov–Smirnov, Shapiro–Wilk, the Q–Q, skewness, and kurtosis (DemiR, 2022; Yang & dovalBerdine, 2021). These test results revealed the following: The Kolmogorov–Smirnov (p = 0,003) and Shapiro–Wilk (p = 0,002) test values were statistically significant, indicating a slight deviation from normality. However, looking at the histogram (Figure 14) by eye showed that the data were mostly bell-shaped and centred around zero. The Q–Q plot also showed that the data points were relatively close to the diagonal line, indicating that the residuals were mostly normally distributed. The results for skewness (-0,291) and kurtosis (1,537) were similarly within the acceptable range of plus or minus 2. Therefore, due to the substantial sample size of 242, the residuals were deemed sufficiently normal for regression and mediation analysis, with visual evidence to support this.

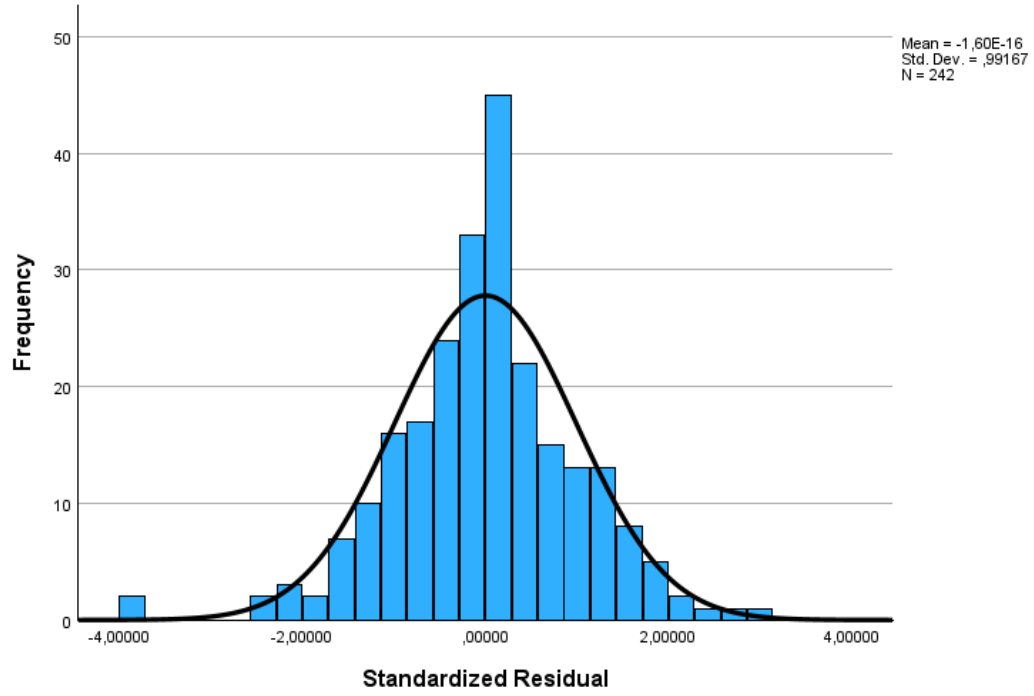


Figure 14: The normality residual histogram (Source: SPSS 2024).

STEP 3.

The final step of the assumption test was to conduct the homoscedasticity assumption test. The process checked the assumption of homoscedasticity by examining a scatterplot of standardised residuals against unstandardised expected values (Djalic & Terzic, 2021). According to Figure 15, the plot indicates that the residuals are randomly distributed around the zero line, with no clear direction or regular pattern. This means that, regardless of the anticipated assumption values, the variance of the residuals remained the same. There were a few mild abnormalities, but they were spread out randomly and didn't show heteroscedasticity (Kumar, 2023). Therefore, the assumption of homoscedasticity was considered valid, indicating that the regression model provides reliable predictions for all estimated values.

Based on the overall assumption results, this study suggests that all assumption requirements were met, and assumptions were considered true and valid. Therefore, there is no need to take any remedial actions, such as changing the data or using weighted regression.

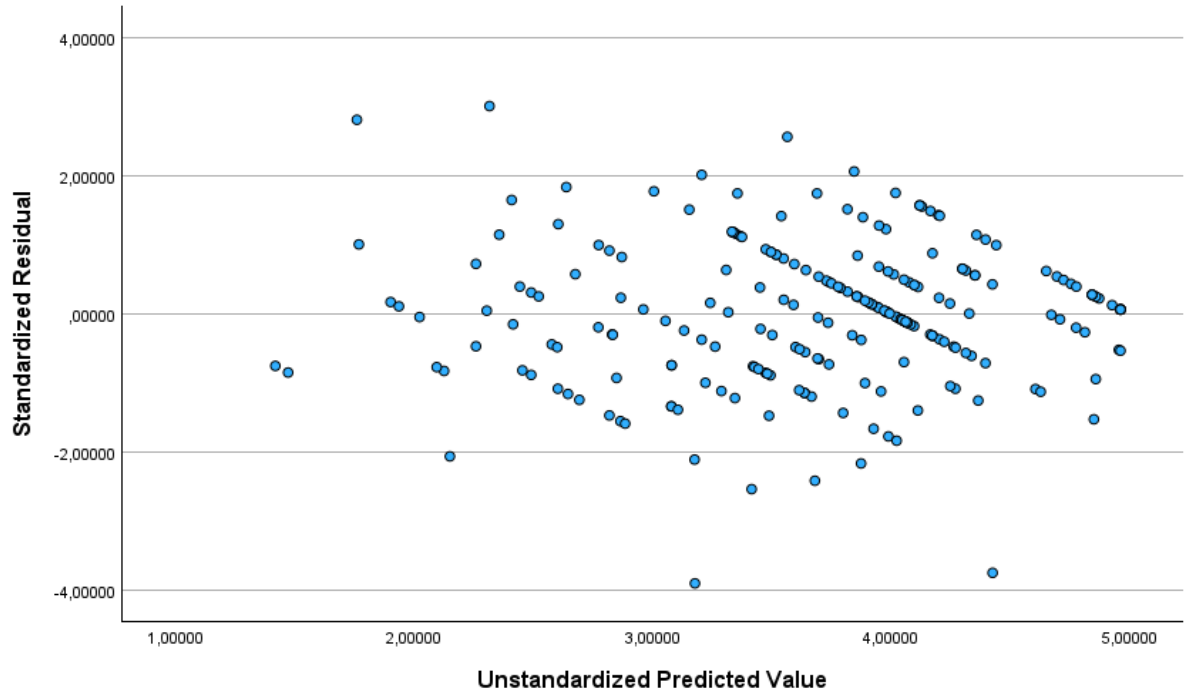


Figure 15: The residual and predicted values scatterplot (Source: SPSS 2024).

5.8. CHAPTER SUMMARY

This chapter provided an analysis of the results aimed at assessing the elements that affect students' intention to utilise mobile learning in academic environments. The data analysis procedure was primarily conducted using SPSS for quantitative analysis and descriptive statistics. The key processes included reliability, EFA, correlation, mediation, multiple regression, path, and assumption testing. The mediation analysis involved the utilisation of Hayes Process Macro (Model 4) in SPSS. The results indicated that attitude strongly moderated the influence of relative advantage, compatibility, and observability on students' usage intention. These results were further confirmed by the tested hypothesis. After completing all relevant regression assumption tests, such as linearity, normality, multicollinearity, and homoscedasticity, the conclusions were deemed to be true and valid. These processes have confirmed that the study utilised strong and accurate statistical models.

CHAPTER 6 – FINDINGS, INTERPRETATION, AND RECOMMENDATIONS

Chapter organisation	
❖	Introduction
❖	Overview of findings, research questions, and objectives.
❖	Findings interpretation
❖	Real-world Scenario
❖	Proposed conceptual model
❖	Summary

6.1 CHAPTER INTRODUCTION

This chapter interprets the principal findings of the study, regarding the use of mobile learning technology by students in HEIs. It went further by highlighting the significance of these findings in relation to the research objectives and the research question. Moreover, recommendations and directions for future research were suggested based on the findings, the literature, and the DOI theory that underpins this study. The other purpose of this chapter is also to highlight how certain factors, such as attitude, influence the practical use of mobile learning in academic settings. Consequently, these interpretations and suggestions were made to address the problems identified in the research and enhance literature knowledge in the IS field. The chapter concludes with a discussion of the study's limitations and directions for conducting similar studies in the future.

Overview of the research findings

An overview of the research findings revealed that: the initial statistical results from two campuses of Vhembe TVET College indicated that out of 301 issued surveys, 242 valid replies were obtained, resulting in an 80% response rate. The results were obtained from the data that were analysed from SPSS through the different processes and tests, such as reliability, EFA,

correlation, mediation, multiple regression, path, and assumption testing. The Cronbach's alpha reliability coefficient result was 0,871, demonstrating a significant internal consistency for this study's measurement scale. The following factors aligned with the conceptual model remained after the data cleaning process of the EFA analysis. These include relative advantage, compatibility, observability, attitude, and usage intention. The tests revealed a moderate correlation between relative advantage, compatibility, and observability towards usage intention, while attitude showed a strong correlation. The multiple regression model, hypothesis testing, and mediation analysis (conducted through Hayes Process macro model 4) aligned with the correlation results. The relative advantage, compatibility, and observability factors had a significant effect on usage intention, while attitude continued to be a significant mediator in explaining why students want to adopt and use mobile learning technology. The Hypothesis for relative advantage and compatibility in relation to usage intention, without attitude as a mediator, was not supported, indicating the strong influence of attitude on students' behaviour. The path analysis and model fit indices followed a similar pattern, where the influence of attitude towards usage intention was significant, as the two were grouped together. Finally, the assumption test requirements were met, and assumptions were considered true and valid without the need for any remedial actions.

Overview of the research questions and objectives,

The primary research question of this study was defined as follows:

- What influences the use of mobile learning technologies by students in HEIs towards digital transformation?

The research question was then followed by three research sub-questions to expand the scope of the study.

- What factors influence students' capabilities to use mobile learning technologies in HEI?
- What challenges and opportunities exist when students use mobile learning in HEIs?
- What influences the relationship between mobile learning and digital transformation in HEIs?

The defined research questions enabled the study to establish achievable research objectives, laying the foundation for data interpretation and recommendations.

- To examine the factors that influence learners' capabilities to use mobile learning technologies in HEIs.
- To investigate the challenges and opportunities that exist when students use mobile learning in HEIs.
- To determine what influences the relationship between mobile learning and digital transformation in ḢEIs.

Interpretation of findings

The results of this study analysis and literature identified numerous critical factors and themes that affect the adoption and use of mobile learning technologies by students in academic settings. These factors were critical in the HEI context of digital transformation and the sustainability of the technology. The identified themes from the reviewed literature included These themes include: IS as the foundation of digital transformation (Bucăţa et al., 2022), mobile learning adoption and long-term sustainability (Alfalah, 2023; Al-Rahmi et al., 2021), completeness, fairness, and equal access (Mateko et al., 2025), AI integration and ethical Use (Baba et al., 2024; Guo et al., 2025; Moya & Camacho, 2024) and implementation and utilisation challenges (Ramchurn et al., 2021; Mabidi, 2024; Mateko, 2024). Moreover, the identified critical factors based on the conceptual model that influence usage intention directly and indirectly were relative advantage, compatibility, observability, and attitude.

Theme 1.

The role of IS as the foundation of digital transformation was notable as it paved the way for modern learning technology to be integrated into HEIs' curriculum. This shows the importance of digital inclusion as a key component to the successful technology integration in HE. Literature confirmed this by demonstrating that the effective integration of information systems in HE improves efficiency in educational processes, administration, and service delivery, thereby promoting statistically informed choices and learner-centred approaches (Bucăţa et al., 2022; Criollo-C et al., 2021). Therefore, mobile learning in TVET colleges will not be successful without IS architectures and systems in place to facilitate digital transformation integration.

Theme 2.

The adoption and sustainability of mobile learning technology are critical factors when dealing with the ever-changing behaviour of students, which calls for the promotion of continuous use. This is because continuous use and sustainability were challenging, especially when mobile learning is to be adopted in underprivileged countries, despite its advantageous aspects. In underprivileged countries, HEIs usually face scarcity or limited technology resources. This aligns well with the key highlights of the literature on this issue, demonstrating the necessity for the purposeful use of mobile learning within integrative digital transformation frameworks to ensure technology enhancement and continuity (Mateko et al., 2025). The majority of rural TVET colleges face similar challenges that hinder the adoption, sustainability, and continuous use of mobile learning initiatives.

Theme 3.

Equity, completeness, and equitable access are vital aspects of HEIs' transformation efforts and include socio-economic and societal challenges that highlight the notable differences between privileged and underprivileged higher education institutions. local studies indicated that unequal access to infrastructure and connectivity data extended educational inequities (Mateko et al., 2025; Shumba et al., 2025) that shows the digital gaps between privileged and underprivileged countries. Global studies have also reaffirmed that device ownership does not guarantee usage, as the cost of mobile internet and connectivity poses a considerable obstacle for many countries (Goksu, 2021; Goundar & Kumar, 2022; Hameed & Sumari, 2024; Lutfi et al., 2022). This means that ownership of smartphones by TVET college students did not guarantee the effective use of mobile learning technology.

Theme 4.

The use of digital innovations was associated with enhanced performance, engagement, and self-regulated learning (Arini et al., 2022) confirming why there is a need for digital transformation in HEIs. However, the use of generative AI tools, such as ChatGPT, has raised other concerns, including data privacy, algorithmic bias, and academic integrity (Mhlanga, 2023). The unethical use of these integrative and predictive technologies has raised concerns about utilisation, prompting the responsible integration of AI with mobile learning. This is a crucial aspect of sustainable digital transformation in the modern digital world, providing insight into the students' shift from technology adoption to utilisation.

Theme 5.

The adoption and implementation of mobile learning technologies come with various challenges for HEIs. These include inadequate institutional support, ineffective educational strategies, technological obstacles, insufficient digital literacy, psychological resistance, and social influences. the results show that students' digital skills and literacy are very important in deciding how well they can use mobile learning resources. HEIs were also responsible for providing proactive institutional support in the learning environment, as this influenced students' interest in mobile learning tools. This includes providing 24/7 assistance and investing in upskilling users, as this improves student willingness to use mobile learning. This clearly aligns with literature suggestions that HEIs need to formulate strategies that enhance students' digital skills, proficiency, and promote investment in sustainable infrastructure that is vital for the adoption and use of mobile technology (Sophonhiranrak, 2021).

The psychological effect of using mobile learning technologies comes with different challenges related to the use of mobile learning. This is because students' attitudes and motivation towards digital learning had a big effect on learning engagement and performance. Similarly, the findings of this study highlighted attitude as a strong predictor of usage intention. Students who perceive mobile learning to be easy to use were more interactive, engaged, and open to HEIs' digital transformation. However, some students resisted the adoption and use of mobile learning because they viewed it as an additional responsibility rather than a helpful instructional tool. This is consistent with the complexity and perceived ease of use elements in the DOI and TAM (Arora et al., 2022; Chang et al., 2022). Moreover, literature has indicated that these factors usually cause adoption challenges such as diminished motivation, inadequate understanding of technology, fatigue from technological engagement, and mental overload, which continue to influence students' use of new technologies in academic settings (Alfalah, 2023; Al-Rahmi et al., 2021; Alturki & Aldraiweesh, 2022).

The impact of cultural, socio-economic, and social influences on students' adoption and use of mobile learning cannot be ignored, especially in the context of developing countries. For example, from the viewpoint of developing countries such as South Africa, which is characterised by many cultures and languages, these problems were particularly evident since educational resources and mobile interfaces continued to inadequately reflect the social reality

of students (Mabidi, 2024; Mateko et al., 2025). In these countries, students' adoption of mobile technology was also influenced by the existence of social pressure in the educational environment. Literature has suggested that fostering peer networks and exciting cultural communities through success anticipation and effective facilitative environments inspired students to embrace mobile learning initiatives (Alzaidi & Shehawy, 2022, Frei-Landau et al., 2022). This also aligns well with UTAUT theory and the findings from Alfalah (2023), who emphasised the importance of facilitating conditions as a key determinant of students' intention to use mobile learning tools.

Despite the highlighted themes, the findings identified critical influential factors that were significant in predicting student usage intention. These factors were relative advantage, compatibility, observability, and attitude. Attitude was noted as a strong predictor of usage intention, although it partially influences the relationships of the other factors through mediation. These research findings align with findings from Al-Rahmi et al (2021) and Lai et al (2022) who strongly endorse mobile learning systems as a sustainability factor, demonstrating that attitudes towards and usage intentions to utilise mobile learning for sustainability positively influence its application and use in education. This was also supported by tested hypotheses (H7, H8, H10, and H12).

The unexpected findings.

During hypothesis testing, an unexpected result was revealed where H1 (relative advantage → usage intention) and H3 (compatibility → usage intention) were not supported. This might have been caused by TVET college students' views regarding the relative advantage, which necessitates the perception that mobile learning may not offer unique or superior benefits compared to traditional learning methods. In the HEI context, students may have viewed mobile learning as merely a convenience tool, rather than a digital transformation initiative, which explains why the H1 hypothesis was not supported. This aligned with the findings from Al-Rahmi et al (2022) which integrated DOI and TAM, and highlighted that relative advantage becomes substantial only when users perceive distinct performance improvements of the technology, such as flexibility, time efficiency, and enhanced results. Moreover, the relative advantage of the technology was notable when students encountered innovative, enhanced skills such as AI tutoring and quick problem-solving solutions when compared to HE's traditional educational mechanisms (Abdalla et al., 2024).

The H3 hypothesis, on the other hand, may have been unsupported due to the misalignment of the institution's technological environment with student perceptions, needs, and understanding. According to Ayanwale & Ndlovu (2024) compatibility assesses the agreement between the learning technology and the established values, requirements, and practices of students. The above aligns with findings from a DOI study by Arora et al (2022), which highlighted that compatibility has low prediction when institutional support, educational methods, or curriculum integration are insufficient. Another DOI study supports this assertion, stating that the lack of major compatibility may be attributed to the innovation's unavailability across all platforms (Fahad & Shahid, 2022).

The real-world interpretation of findings.

The practical implementation of mobile learning in HEIs

The practical implementation of mobile learning technologies as a digital transformation strategy requires HEIs to have innovative approaches incorporating technology and educational aspects. This approach ensures students can access suitable devices, functional network infrastructure, and proper technology, facilitating conditions for effective mobile learning initiatives. Mobile learning users must be well-trained to utilise these technologies effectively, creating a positive academic environment that consistently delivers as expected. Thus, the effective implementation of mobile learning approaches requires attention to related challenges as it involves several cultural, social, educational, and technological aspects. These aspects, such as technology, change over time and may require changes or modifications to HEIs' approaches. Therefore, practical implementation must be guided by technology adoption frameworks, such as the DOI theory, and institutional policies to deliver sustainable digital transformation initiatives.

The technological aspects of mobile learning to enhance academic operations

Mobile learning education optimises academic functions by utilising key technological aspects to enhance students' access to several educational resources, promoting engagement and customising the overall learning experiences. These key technological aspects include mobile devices, network infrastructure (physical and wireless), mobile learning systems, and various educational applications. As such, this form of education required the utilisation of mobile devices such as smartphones, tablets, and other portable devices, enabling students to access content from any location (Sisouvong & Pasanchay, 2024). The most recent versions of mobile

devices enable students to learn, interact, and exchange ideas at any time and from anywhere, becoming a crucial component of the educational technology aspect in HE. However, several challenges exist with the HE environment that limit the technological aspects of mobile learning from delivering what it is intended to deliver. These challenges include poor technology infrastructure and a lack of skills to operate systems and applications. Nevertheless, many institutions were striving to address these challenges by enhancing technology infrastructure, offering training programmes to mitigate skills deficiencies, and pursuing financing opportunities to enhance educational technology activities (Opesemowo & Adekomaya, 2024).

The educational aspects of mobile learning to enhance academic operations.

The educational aspects of mobile learning involve technology-enhanced academic operations, providing students with more freedom and a sense of control over individual studies. This allows students to learn at the individual own convenience, pace, and provides them with access to additional resources. However, students must be able to clearly see the relative advantage of using mobile learning and align fully with the needs, experiences, and understanding within the learning environment. These efforts encourage students to be interested, fully engaged, and to learn at own convenience and time. As a result, students' attitude that fosters usage intention will improve, leading to the adoption and use of mobile learning tools.

The advantageous aspects of mobile learning included location flexibility, efficiency in terms of time and effort, as well as the ease of use and availability of learning materials, which contributed to the acquisition of knowledge (Alshurideh et al., 2023). This is due to the increasing accessibility of various digital materials, which have become essential for students because of the transformative impact of digital technology on communication and participation. In recent years, one significant method used to enhance and elevate learning experiences has been the integration of AI technology into mobile learning (Moya & Camacho, 2024). Therefore, the incorporation of these innovative technologies into South Africa's HE system offered substantial opportunities for improving academic programmes and attaining sustainable development objectives (Opesemowo & Adekomaya, 2024).

Student significant interest in using mobile learning technology

Mobile learning technology designers must ensure that the technology interface is visually appealing (attractive) and makes learning more engaging for students and educators. This interest is driven by the belief that it might lead to personalised learning, enhanced cooperation,

and access to educational materials at any time and from anywhere. HEIs can assist students by ensuring that learning applications are integrated with other engaging applications and software that capture student attention and encourage the use of technology. For example, the incorporation of mobile learning with other applications or software that promote engaging education (social media platforms and innovative and interactive learning mechanisms), rewards and gamification, communication, collaboration, responsive and quick access to several learning resources (digital libraries), and immersive AI-powered mobile learning. However, these must align well with students' needs, understanding, and experiences, ensuring compatibility with the learning environment to enhance the effectiveness of the technology. Thus, incorporating these applications, features, and software can enhance the HEI's digital transformation strategy through mobile learning, promoting an attractive academic environment and an enjoyable, personalised learning experience for students. Therefore, the primary responsibility for attracting interest lies with the institution.

The role of HEIs in promoting an attractive and interesting mobile learning environment

Implementing a digital transformation strategy is significant for HEIs looking to create a transformed learning environment, and students' adoption is crucial. Institutions must ensure that mobile learning environments are more compatible, attractive, and engaging for students. Strategic policies must be implemented to support the development of innovation and new learning approaches that promote changes in students' attitudes and behavioural intentions. Moreover, responsive infrastructure, faster connectivity mechanisms, and the approval of mobile device usage in the classroom must be ensured.

Secondly, promoting mobile learning initiatives can be increased by encouraging stakeholders to utilise these tools in academic settings. Educators play a crucial role in changing students' attitudes and intentions to use technology tools as the developers of learning instructions. HEIs must ensure that educators' digital literacy skills are continually enhanced for the benefit of students.

Lastly, HEIs must be active in ensuring:

- Visibility of benefits and actual mobile learning technologies usage.
- Protection of students' data to remove the fear of perceived risk.
- Ensuring ease of use and less complex learning initiatives.

- Monitoring technology changes and students' behavioural intentions change over time.
- Ensuring that learning tools are compatible with other learning tools used or incorporated into mobile devices.

The role of students in showing interest in mobile learning initiatives.

To successfully overcome challenges and see the effect of mobile learning initiatives on learning capabilities, students must adjust and adopt new learning methodologies and change to a new learning style. This learning style is based on embracing mobile devices, which necessitate a learner-centred approach, and utilise the distinctive capabilities and benefits. Students must learn to familiarise themselves with available mobile learning applications, including knowledge of operations, navigation, and features. Understanding how to access and use learning resources on smaller mobile devices can remove students' element of complexity and perceived risk, growing new abilities to operate several mobile learning initiatives. Therefore, students must see mobile learning as a digital transformation initiative rather than just an enhancement tool to traditional mechanisms. This will ensure that the relative advantage of the technology is notable, and compatibility perception improves. In the long term, attitude will improve, leading the utilisation of the technology.

6.2 MOBILE LEARNING ADOPTION: PROPOSED MODEL FOR HEIS.

The study has developed a proposed model, supported by findings interpretation and existing literature, which is illustrated below. HEIs can use this as a guide for strategic digital transformation options. A practical scenario for the conceptualised model of the student's utilization of mobile learning in the HE environment was then developed to further explain the model. This provides a realistic example of how TVET college students perceive mobile learning technology in an academic setting. This scenario is based on the technological, educational, Psychological, and institutional factors that can create an effective learning environment and attract the acceptance and use of mobile learning in a South African HE context.

Scenario Example:

Phathu is an NCV Level 2 student at Vhembe TVET College and is enrolled in a qualification that includes a module utilising computing or computers as part of the curriculum. The institution recently rolled out a digital transformation strategy and chose mobile learning, for

which it advised encouraging students' utilisation. The institution has granted approval for smartphone usage on campus, and he owns a similar device. Following the guidelines of the educators, the institution has implemented a good responsive connectivity mechanism on and off campus for use by all students as part of the strategy rollout. Moreover, the institution continually monitors and provides 24/7 support to ensure a strong and responsive infrastructure. The educator assigned students a challenging computing task that requires internet access and collaboration with other students, while ensuring access to college digital libraries.

Students at the college are now utilising mobile learning every day, acquiring a combination of technological and educational aspects that promote effective learning. These are ways of bringing together quality course content, social interaction, collaborative groups (such as MS Teams, WhatsApp, and Google Meet), and AI-powered feedback systems, and Phathu has access to all of these. Thus, this combination of technology and education has encouraged Phathu to learn more effectively with greater freedom and control over the personalised learning experience. He has noted the relative advantage of mobile learning, which is compatible with his experiences, needs, and understanding in the learning environment. He can now complete his complex academic tasks without worrying about geographical location and time, and has found it convenient to learn and collaborate with others within the educational environment.

The lesson learnt from the proposed model and scenario:

Scholars have often called for integrating two or more theories in understanding certain elements of technology adoption and use. This study, therefore, proposes a new conceptual model based on the study findings and integration of other IS theories. These theories include the DOI (Arora et al., 2022), UTAUT2 (Hameed & Sumari, 2024), and Cognitive Load Theory (CLT) (Curum & Khedo, 2021) . This form of integration will help HEIs understand the technological and psychological aspects essential for the adoption and effective use of mobile learning in academic settings.

According to Curum & Khedo (2021) Cognitive load refers to the cumulative strain imposed on a learner's mental abilities during the learning process, which is significant to learning and involves mental operations. This study proposes a conceptual model that highlights the need to simplify the complexity of mobile interfaces and address the demands of multitasking compatibility, as these factors may lead to cognitive overload and hinder students' sustained engagement in mobile learning technology education. It highlights the importance of

developing policies towards creating an attractive and engaging learning environment that considers the psychological well-being of students. usage intentions and actual use. Thus, by examining the effect of mental load and attitude on usage intention, these predictors can be influential in determining usage intention and actual use.

Despite emphasis on the technological and psychological components, it is equally important that the institutional aspects of the strategy for implementing mobile learning are not overlooked. HEIs must provide learners with effective facilitative support mechanisms that ensure an uninterrupted user experience when using mobile learning technological systems (Alfalah, 2023). The model emphasises the importance of developing strategies that address the technological, institutional, and psychological aspects of the digital transformation initiative. Therefore, the scenario and proposed model demonstrate that HEIs must recognise the importance of having the right technology, infrastructure, and learning environment that is sensitive to the psychological well-being of students. This scenario can be applied by HEIs in a practical environment when implementing sustainable digital transformation initiatives to ensure the delivery of quality education and student academic success.

Important recommendations.

This study's findings and interpretations helped the scholar provide various recommendations to improve the effective utilisation of mobile learning technology and facilitate digital transformation in HEIs.

Improvement of the technological infrastructure to facilitate good learning conditions.

HEIs should prioritise the establishment of a solid and dependable technological infrastructure to facilitate mobile learning. This involves delivering high-speed connectivity mechanisms throughout the college campuses, ensuring mobile compatibility of the online learning environments. Moreover, ensure 24/7 technical support and continuous accessibility of learning materials for students. Strategies aimed at assisting students by collaborating with network providers must be implemented to enhance data affordability, as some of the HEIs, such as Vhembe TVET College, are situated in rural and economically disadvantaged environments.

Promote technology literacy, skills, and competencies for an effective learning environment.

Studies have highlighted that several students in South African HEIs lack the required technological skills for efficient mobile learning, sometimes due to the unpreparedness of the institution (Mateko et al., 2025; Shumba et al., 2025). It is therefore recommended that HEIs incorporate technological literacy programs into the curriculum and provide frequent training and guidance for both students and educators. These trainings should also ensure that students and educators recognise the relative advantages of using mobile learning over traditional learning methods. This study takes the perspective that developing these skills will enhance students' confidence and proficiency in utilising mobile learning tools in educational settings.

Promote an attractive mobile learning environment that improves students' psychological well-being.

HEIs should ensure that students can observe the usability and performance results of mobile learning to raise their knowledge and awareness of these learning tools. This will raise expectations of the advantages of mobile learning, thereby increasing students' readiness to embrace these technologies. Thus, HEIs should introduce promotional activities with incentives, including recognition or certification for project involvement, curriculum-based gamification, and identification of technological learning challenges. Strategies should be implemented that consider the psychological well-being associated with the use of mobile learning, particularly in relation to its potential to increase mental load. Moreover, IS executives, staff, and educators should serve as examples that the efficient utilisation of mobile learning tools can enhance student engagement, collaboration, and learning outcomes. This can lead to positive changes in students' attitudes, resulting in an increased intention to use.

Development of institutional digital transformation strategies and policies aligned to the creation of an effective mobile learning environment.

It is recommended that HEIs establish strategies and strong policies and procedures that facilitate the incorporation of mobile learning into an effective digital transformation strategy. This should also include the incorporation of AI-powered mobile learning in academic settings, with policies that consider data privacy, security, ethical use, equitable access, and quality assurance in technological education. Therefore, HEIs' management should provide assurance that mobile learning evolves into a sustainable component of the educational process.

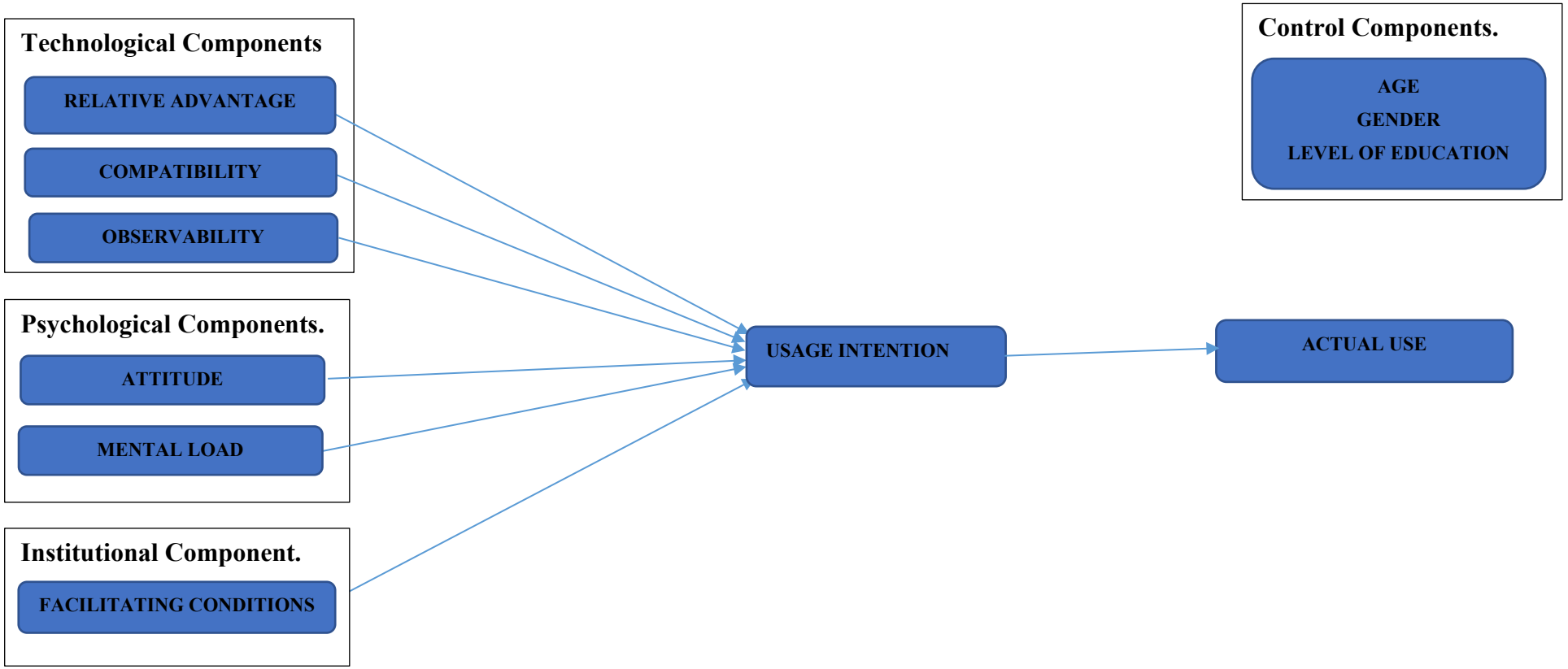


Figure 16: The proposed conceptual model for utilisation of mobile learning in the HE environment.

6.3 CHAPTER SUMMARY

This chapter discussed the interpretation of the principal findings of the study, regarding the use of mobile learning technology by students in HEIs, by highlighting the significance of these findings in relation to the research objectives and the research question. It highlighted the identified themes and significant predictive factors, as well as the supported and unsupported hypotheses. The discussion continued with the chapter clarifying the importance of the findings in providing a real-world context within the perspective of HEIs' educational environment. Moreover, a real-world scenario and proposed conceptual model were developed to highlight aspects related to the technology, institution, and the mental well-being of students. It concluded by providing recommendations and highlighting opportunities for HEIs and students to enhance initiatives, thereby improving the effectiveness of mobile learning, which can lead to improved performance, engagement, collaboration, and learning outcomes. The chapter that follows gives the study reflections and conclusions.

CHAPTER 7 – STUDY REFLECTIONS AND CONCLUSIONS.

Chapter organisation	
❖	Introduction
❖	Research objectives reflection
❖	Research questions reflection
❖	Study methodological evaluation
❖	Study implications
❖	Study limitations
❖	Directions for future research
❖	Summary

7.1 INTRODUCTION

This chapter presents the overall reflections on the study's interpretation based on its objectives, research questions, and the theoretical and practical implementation. The study limitations and recommendations for future research are also discussed. Thus, this chapter aims to validate whether the objectives and research questions were addressed, confirming whether the DOI theory and study model were fit to address the important factors contributing to student adoption of mobile learning technology in HEIs. The chapter also suggests the direction for future research studies that can be conducted.

7.1.1 Study chapter organisation

The chapters of this study were organised and outlined as follows:

Chapter 1 – Introduction

The chapter began by introducing the field of study, defining key terms, and providing research context regarding South African HE. background of the study, defining the problem statement, the research objectives and questions, defining key terms, and highlighting the theory that

underpins this study. The research methodology, hypothesis, and conceptual model were introduced. In concluding the chapter, the study outlined the key findings, as well as the theoretical, methodological, and practical contributions.

Chapter 2 – Literature review

The chapter presents a comprehensive and systematic literature review of mobile learning, synthesizing 31 studies. The chapter reviewed studies based on implications on theory, country context, and methodology. The study further clarifies some of the challenges experienced by students during the adoption and use, as well as clarifying the literature links to the study's conceptual model and developed hypotheses. A short summary of the chapter was also provided.

Chapter 3 – Methodology

The chapter introduces the methodological aspects of this study, including the paradigm, research approach, and data collection methods employed. The study compared three approaches within the research dynamic, which were useful, but only the quantitative approach was chosen for use. The survey strategy was employed as the preferred data collection methodology to assist the study in addressing research questions. It concludes with a discussion and summary of the chapter.

Chapter 4 – Study Frameworks

This chapter introduces the various frameworks used in the study. A comparative analysis of four technology acceptance theories that were not adopted was performed. Ultimately, the adopted DOI theory and its elements are discussed. An illustration of the conceptual model was drawn from which the developed hypotheses were derived. The chapter ends with a summary of the discussed materials.

Chapter 5 – Data analysis and results

The chapter introduces the different aspects of analysis and the participants and questionnaire information. It continues by developing the measurement models used to test reliability and validity. The analysis procedure was primarily conducted using SPSS for quantitative analysis and descriptive statistics. The key processes included reliability, EFA, correlation, mediation, multiple regression, path, and assumption testing. The mediation analysis was conducted using

the Hayes Process Macro (Model 4) in SPSS. It further performed an assumption test and model fit before concluding and summarizing the chapter.

Chapter 6 – Findings, interpretation, and recommendations

This chapter analyses the interpretation of the study's primary findings on the utilisation of mobile learning technology by students in HEIs, emphasising their importance in relation to the research aims and the research question. It identified themes and notable predictive factors, together with the validated and unvalidated hypotheses. The chapter clarifies the significance of the findings by providing a practical context within the HEI educational environment, demonstrating a scenario, and proposing a conceptual model. It concluded by offering recommendations for HEIs to incorporate into future strategies and policies.

Chapter 7 – Study reflections and conclusions

This chapter reflects on the study's results and findings, interpreting the objectives and research questions, and highlights the study's implications. This chapter further presents the evaluation of the methodologies used in this study. The validation of whether the objectives and research questions were addressed confirmed whether the DOI theory and study model were suitable for addressing the important factors contributing to student adoption of mobile learning technology in HEIs. The chapter concludes with remarks and suggests directions for future research.

7.2 OBJECTIVES DISCUSSION

The study's objectives are discussed individually to validate whether the employed models supported the aim and assisted in answering the overall research questions.

7.2.1 First study objective discussion

"To examine the factors that influence learners' capabilities to use mobile learning technologies in HEIs."

The above objective aligns well with this study based on the following findings: The findings revealed important themes and predictive factors that influence students' capabilities to use mobile learning in HEIs. The results revealed that students' abilities were influenced by several factors that contribute to the intention to use mobile learning tools in academic settings, which can be categorised as technological, institutional, and psychological components. These include DOI factors such as relative advantage, compatibility, and observability, as well as access to

mobile devices, level of digital literacy, and access to infrastructural measures like responsive connectivity. As a result, the findings suggested that students have varying technological skills and rely primarily on the use of smartphones, with a dependence on institutional provision of connectivity mechanisms. Students' learning capabilities are influenced by the availability of these components; when they are lacking, it becomes more challenging for them to use mobile learning efficiently. Moreover, students' attitudes were found to be a strong predictor of intention to use, highlighting the importance of having a positive attitude to improve learning capabilities. Generally, these factors highlight the need for technology preparedness for both HEIs and students. HEIs achieve this by ensuring the availability of responsive infrastructure, 24/7 technical support, and accessibility to facilitative tools. On the other hand, students must view mobile learning as advantageous and a digital transformation mechanism that influences learning capabilities compared to traditional methods.

7.2.2 Second Study objective discussion

"To investigate the challenges and opportunities that exist when students use mobile learning in HEIs."

The challenges.

The findings of this study revealed several themes, with one related to several notable challenges affecting the use of mobile learning in HEIs. These include inadequate institutional support, ineffective educational strategies, technological obstacles, insufficient digital literacy, psychological resistance, and social influences. The identification of the challenges highlights issues that can hinder the use of mobile learning and potentially limit opportunities for an effective learning environment. Thus, most students, especially in disadvantaged areas, typically face challenges such as a lack of responsive connectivity, technical support and are dependent on the institution's connectivity mechanisms. The high costs associated with data, gadgets, and low digital literacy skills, as well as unequal access, were also notable. These problems make it more challenging for students to utilise mobile learning effectively.

The opportunities.

Despite the challenges available in HEIs, notable opportunities were identified that can improve the mobile learning environment. The results revealed an increased number of students who are

smartphone owners, which is favourable for digital learning mechanisms such as mobile learning. These students have observed how mobile learning tools can enhance educational activities, thanks to the technology's flexibility and visibility. The observability of technology performance and results, combined with students' positive attitude, proved to be significant facilitators of intent to use. This demonstrates that when students recognise the advantages of mobile learning and individual attitudes are favourable, they are more willing to adopt and use the technology in education. These opportunities indicate that HEIs can enhance the mobile learning environment by investing in infrastructure, digital skills, and ensuring that students are aware of the advantages of these tools, which makes them more useful and less difficult.

7.2.3 Third study objective discussion

"To determine what influences the relationship between mobile learning and digital transformation in HEIs."

The results of this study identified several factors that contribute most effectively to clarifying the relationship between mobile learning and digital transformation in HE. The DOI factors, including relative advantage, compatibility, observability, and student attitudes, were identified as significant factors that enhance the effectiveness of mobile learning in supporting broader digital transformation initiatives. This means that students' perceptions of mobile learning advantages affected individual views of digital transformation in HE. However, even though the relative advantage and compatibility hypotheses were not supported, these factors had a significant impact on the students' views, which ultimately became the primary reason for the adoption of mobile learning. Consequently, students' perceptions about utilising technology in HE have a greater effect on digital transformation compared to the technology itself.

The ability to observe and practically experience the benefits of mobile learning in academic settings was equally important. When students can see the practical benefits of mobile learning, they are more likely to use it, which in turn accelerates its adoption and use in educational settings. However, the relationship between mobile learning and digital transformation can also be influenced by other factors affecting institutions and students. These include infrastructure components, such as responsive connectivity, approved campus smartphone use by students, and a high level of digital literacy and skills. Moreover, these factors influence the relationship by allowing HEIs and students to collaborate and fully engage in a digital learning environment.

This effort can positively shape students' attitudes through the practical visibility and perceived advantages of mobile learning facilitated by institutional factors that promote widespread adoption, thereby influencing the relationship between mobile learning and digital transformation in HE.

7.3 RESEARCH QUESTION DISCUSSION

The second part of the discussion aims to validate whether the study's results and findings address the following developed sub-questions. These sub-questions were:

- What factors influence students' capabilities to use mobile learning technologies in HEI?
- What challenges and opportunities exist when students use mobile learning in HEIs?
- What influences the relationship between mobile learning and digital transformation in HEIs?

7.3.1 Research sub-question one

“What factors influence students' capabilities to use mobile learning technologies in HEI?”

This study thoroughly addressed this sub-question by identifying several key factors that jointly influence students' capabilities to use mobile learning in HEIs. These include DOI factors such as relative advantage, compatibility, and observability, as well as access to mobile devices, level of digital literacy, and access to infrastructural measures like responsive connectivity. For example, 76,85% of Vhembe TVET college students own smartphones, which is a major facilitator of digital learning. Access to dependable connectivity was associated with 58.26%, indicating the importance of a reliable connectivity mechanism, even though it was provided by the institution. Furthermore, nearly half of the student participants demonstrated strong technology skills, despite many falling into categories with scores below 25%. Technology skills were significant as they directly affect students' confidence and ability to use mobile learning tools effectively. This highlights the importance of institutional support in providing connectivity mechanisms, upskilling users, and providing motivation to students, which later enhances capabilities to use mobile learning.

The technology innovation characteristics, such as the benefits of mobile learning, its alignment to students' needs, value, and understanding, as well as the practical observation of others using the technology, were crucial in influencing students' capabilities. The strongest predictor of the

ability and willingness to use mobile learning technology tools was attitude, highlighting that students with a positive attitude felt more confident in using the technology, even when other aspects were not as favourable.

7.3.2 Research sub-question two

"What challenges and opportunities exist when students use mobile learning in HEIs?"

The study's results and findings revealed several challenges and notable opportunities that are important for addressing this research sub-question. These include insufficient institutional support, inefficient educational approaches, technological barriers, inadequate digital literacy, psychological resistance, and social factors. challenges such as unreliable connectivity, low technology literacy, skills, device and data costs, as well as problems associated with the simplicity and usability of the mobile interface. The anytime, anywhere mobile learning characteristics could be hindered, as a large number of students are fully dependent on college-provided connectivity, which limits the effectiveness of the technology. Moreover, students with limited technological skills are more motivated to view mobile learning as complicated or challenging to incorporate into educational practices. These students also highlighted uncertainties over data expenses, privacy vulnerabilities, and the perception that technical malfunctions could adversely impact academic achievements.

Notwithstanding these challenges, significant opportunities exist that can help enhance the effectiveness of mobile learning. More than 75% of students already possess smartphones, which facilitate digital learning and can distinctly assist students in recognising the advantages of mobile learning through institutional learning environment practices and peer interactions. Moreover, these students had favourable attitudes, which strongly facilitate intent as well as perceived compatibility that aligns well with students' needs, understanding, lifestyles, and experiences of academic requirements. Thus, despite the continuous challenges existing in HEIs, the combined study findings suggest that these students are generally motivated and better equipped to adopt mobile learning educational settings. This means that the HEI already has a strong foundation for establishing mobile learning as a significant catalyst for digital transformation.

7.3.3 Research sub-question three

"What influences the relationship between mobile learning and digital transformation in HEIs?"

According to the study results and findings, the relationship between mobile learning and digital transformation in HEIs is mostly affected by students' attitudes towards the technology, which significantly predict the willingness to use. This is despite the relative advantage, compatibility, and observability characteristics of these technologies in academic settings. When students have a positive attitude, they are more likely to utilise mobile learning in educational settings, thereby influencing the relationship between mobile learning and digital transformation.

Technological literacy skills, device access, and reliable connectivity were other notable factors that can influence the relationship between mobile learning and digital transformation, making it stronger or weaker. Ultimately, digital transformation is strengthened when HEIs enhance technology infrastructure, upskill and motivate students on effective technology use, and promote mobile learning visibility on campus. These efforts could also be achieved by fostering a positive attitude amongst students, as well as aligning mobile learning with the students' needs, understanding, values, and past experiences. This means that HEIs' support, preparedness, and technology readiness, as well as students' technology knowledge and awareness, are influential to the relationship between mobile learning and digital transformation.

7.3.4 The main research question discussion

“What influences the use of mobile learning technologies by students in HEIs towards digital transformation?”

This study’s findings clearly answer the research question and align well with the established and validated results. This is because factors that influence the use of mobile learning by students in HEIs were identified and validated, aligning well with findings from previous literature. Several factors, categorised as psychological, technological, and institutional, influence the use of mobile learning by students to facilitate digital transformation. The study results indicate that students' attitudes towards mobile learning are the significant predictive factors influencing usage intention, adoption, and utilisation in academic settings in a manner that facilitates digital transformation. Other factors were demonstrated through students' engagement with various events that happen in the learning environment. For example, students are more likely to use mobile learning in academic settings when they perceive advantages, such as its usefulness, ease of use, and alignment with academic needs.

The above also aligns well with the identified factors that form the innovation characteristics from the DOI theory. The important factors were relative advantage and compatibility, for which the hypothesis was not supported. However, when mediated by students' attitudes, they influence student willingness to utilise mobile learning, thereby affecting adoption and actual use. Moreover, the observability factor demonstrates the level to which students can practically observe the effective use of mobile learning innovation by others, which influences adoption and facilitates the spread of digital learning practices within the HEIs' learning environment.

The use of mobile learning technologies is also affected by students' access to smartphones, technological literacy, and of dependable connectivity as well as institutional support. These issues highlight the need for institutional preparedness, awareness and technology readiness impact if students can use mobile learning technology or not. However, speedy digital transformation efforts are facilitated when these conditions are right for mobile learning to form a bigger part of everyday academic life for students. HEIs can support these initiatives by shaping students' attitudes by offering tangible rewards and certification to aid engagement and collaboration. These institutional initiatives can promote or hinder the use of technology involvement in the learning environment, leading to effective digital transformation.

7.4 STUDY METHODOLOGICAL EVALUATION

7.4.1 Justification for choosing a quantitative research method

Given the widespread adoption of mobile devices and the growing body of literature on mobile learning technology, this study employed a quantitative method, as it facilitates hypothesis testing and conclusion formulation based on numerical data. It also permits statistical analysis and the establishment of correlations between variables, which is appropriate since the study involved several students who were not pre-selected for study participation. Other benefits of quantitative research include the ability to validate theories (DOI), assess cause-and-effect relationships, forecast one variable based on another, enhance efficiency, and minimize researcher bias when interpreting results. Thus, this approach allowed the study to answer the research questions and achieve the set objectives. The study was conducted at Vhembe TVET College, on two major campuses: Tshisimani and Makwarela.

7.4.2 Data collection techniques validation

A survey was conducted using a two-part, structured questionnaire to achieve the study's objective and address the research question. The collected data were then analysed using statistical software (SPSS) to ensure proper reliability and internal consistency. The interpreted results aligned well with the questionnaire content, conceptual model, and study objectives, assisting the study in evaluating the use of mobile learning technology by students as a digital transformation strategy in the HE academic environment.

7.4.3 Unit of analysis validation

The survey was conducted through a structured questionnaire consisting only of registered students from Vhembe TVET College, an HEI located in the Vhembe area in the Limpopo province. Some of the questions on the questionnaire were adapted from previous literature. The questionnaire was physically distributed to students on two campuses of the college.

7.5 STUDY IMPLICATIONS

The results and findings of this study revealed aspects that have both theoretical and practical implications for HEIs and students using mobile learning tools.

7.5.1 Theoretical implications

According to Sahin (2006), who provided a detailed review of Rogers' (2003) DOI theory in several diffusion studies, suggests that relative advantage and compatibility are regarded as equivalent, despite conceptual distinctions. This aligns with the study's analysis results, which confirm and validate the DOI theory evidence, suggesting that relative advantage and compatibility should be combined into a single element (IP). The results also revealed that IP and observability (OB) have a substantial impact on RB. The theoretical alignment was again confirmed by the study findings, revealing that even though the relative advantage and compatibility factors hypothesis lacked support, they influenced students' views and affected the intention to engage in mobile learning. Together with observability, these factors influence usage intentions and actual usage. However, the most significant factor influencing students' intention to use mobile learning is attitude. This means that when students possess a positive attitude towards technological innovation, they are likely to be influenced to adopt and use it in academic settings. The change in attitudes can promote engagement and collaboration with peers, leading to the spread of mobile learning technology across HEI campuses.

Ultimately, these implications demonstrate that students' perception of the technology benefits, usefulness, simplicity, and alignment with educational needs, as well as visibility, are important factors that affect whether students adopt and use it. This theoretical perspective is significant for HEIs when implementing a technology innovation as a digital transformation initiative.

7.5.2 Practical implications

Practically, implementing mobile learning technology requires the involvement of HEIs and stakeholders, such as students and educators, for the progress and success of the innovation. This means that HEIs such as Vhembe TVET College must:

- Make mobile learning technologies better for students by ensuring that these tools are easier to use, compatible with existing systems, and advantageous over traditional learning mechanisms. (relative advantage, and compatibility)
- To promote students' practical use of the technology by ensuring visibility and exposure around campus. (observability)
- Upskill and motivate students through regular training workshops, certification orientation, seminars, and promotional incentives to help enhance knowledge and awareness.
- Ensure the effective diffusion of the technology into the campus social system and academic environment by sharing the technology's success stories, performance, benefits, and positives, thereby attracting a change in students' attitude and intention to use mobile learning tools.

Overall, if implemented correctly, these steps can significantly enhance the institution's implementation efforts, adoption, and actual use of mobile learning tools in the academic environment, ultimately improving students' learning experiences.

7.6 STUDY CONTRIBUTION AND CONCLUDING REMARKS

This study has significantly contributed to the growing body of literature in IS, with a specific focus on mobile learning in HE, particularly in a developing country such as South Africa. While the majority of the reviewed papers were global studies, this study provides context-specific evidence for South Africa regarding the use of mobile technology and has identified the factors and challenges influencing students' intentions to adopt digital technologies in the

learning experiences. This knowledge enhances the local understanding of mobile learning technologies in under-resourced learning settings. Moreover, it clarified and acknowledged the existence of challenges and notable opportunities presented by mobile learning. These aspects highlight the enhanced accessibility, flexibility, and collaborative learning nature of mobile learning, which significantly provides policymakers and HEIs with evidence to support targeted digital transformation initiatives.

By determining the factors that facilitate or hinder students' technology competence, the study provides insight into where South African HEIs could focus and allocate resources in terms of the provision of training, orientation, and support systems. This was done by examining students' technology skills level, source of connectivity, and the status of technology usage, rather than based on assumptions.

Another notable contribution relates to the demonstration of an existing relationship initiated by the implementation of mobile learning as part of digital transformation within the South African HEIs' learning environment. Unlike most of the reviewed papers, this study links the use of mobile learning by students to the preparedness and support of HEIs, clarifying digital transformation as a strategic or policy aspect of an institution. This is demonstrated by highlighting that student engagement with mobile learning technologies extends beyond being an educational technology but a crucial facilitator of digital transformation.

The study's hypothesis regarding relative advantage and compatibility lacked support, whereas it was supported in other studies reviewed that were not applicable within the context of South African realities. This theoretical contribution, underpinned by the DOI theory, identifies applicable factors and adoption characteristics relevant to the South African context, and provides reasons why they do so. Overall, these are strategic contributions that enhance the South African HEIs' policy discussion on digital inclusion in learning settings, including equal access, inequalities, and future-oriented education. This is crucial for the long-term impacts and sustainability of mobile learning, which enhances students' academic performance and achievement.

7.7 STUDY LIMITATIONS

The study revealed several limitations that were beyond the researcher's control:

- The participants in this study were students, excluding lecturers and support personnel, which may not present the actual reflection of technology use at Vhembe TVET College, besides the fact that some lecturers and support staff may be enrolled as students at the same institution.
- Some questionnaires were completed in a classroom environment in the presence of lecturers and peers, which may have caused some respondents to be socially biased or give copied or inaccurate information when completing the questionnaire.
- The study was conducted at Vhembe TVET College (a single institution), falling under HE, meaning that the results and findings may not be generalisable to other colleges in Limpopo province or the rest of South Africa. Vhembe TVET College students do not necessarily represent students in other South African HEIs.
- Even though the study used the DOI theory and all its elements, it did not use other theories' elements relevant to technology adoption, such as TAM, UTAUT, TTF, and DeLone and McLean. For example, these theories have additional elements, such as system quality and social influence, that can interact effectively with the DOI element, which could significantly impact the outcomes of this study.
- The removal of problematic elements, such as complexity, trialability, and perceived risk, to enhance the reliability scale and internal consistency, may have hindered the complete theoretical validation of the study.
- The study was limited to measuring the students' use of mobile learning technology. Hence, other long-term impacts of mobile learning, such as academic performance, continuous engagement, and learning outcomes, were not measured and unvalidated.
- Data collection took place at a particular stage of time, and information about mobile learning may have been a wake-up call for some students, which may have caused a change in attitude and behavioural intention to experiment with and use mobile learning tools.

7.8 DIRECTION FOR FUTURE RESEARCH

To assist the global education society in understanding and using mobile learning in HE as a digital transformation strategy, future studies should conduct follow-up investigations by adding the following:

- Combining the adopted theoretical frameworks to better understand student attitudes and behaviour towards technology adoption.
- Changing the unit of analysis (including educators and management) and research environment (including more colleges in the Limpopo province) to examine the impact of mobile learning technology on improving the delivery of quality education.
- Conduct similar studies in other developing African countries experiencing similar educational challenges and concerns.

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APPENDIX A: QUESTIONNAIRE TEMPLATE

STUDENT SURVEY QUESTIONNAIRE:

Dear Participant:

You are kindly invited to complete the survey questionnaire to fulfil my Master of Science degree in computing, enrolled with the University of South Africa (Unisa) under the research title:

"**A Model to Implement Mobile Technology in Higher Education Institutions to Support Digital Transformation".**

The questionnaire has been specially designed for students at Vhembe TVET College, and participation in answering this questionnaire is entirely voluntary, with no obligation to do so. You are requested to answer all the questions as truthfully as possible, as your contribution is important for meeting the research objectives. All participants' responses will be kept anonymous, and information will be kept confidential and used only for the purpose of this research. Your cooperation in answering this questionnaire is highly appreciated.

PLEASE TICK / CROSS ONE OPTION TO SELECT YOUR CHOICE APPLICABLE TO THE SECTIONS AND QUESTIONS BELOW.

SECTION A (STUDENT BIOGRAPHICAL INFORMATION)

1. What is Your Applicable Age Group?

☐ 15-19 ☐ 20-25 ☐ 26-30 ☐ 31-35 ☐ >36

2. What is Your Gender?

☐ Male ☐ Female ☐ Other

3. What is Your Applicable Education Field of Study?

☐ NCV Business Studies ☐ NCV Engineering Studies ☐ Nated Business Studies
☐ Nated Engineering Studies ☐ Other

4. What is Your Applicable Education Level?

☒ NCV level 2 ☐ NCV level 3 ☐ NCV level 4 ☐ N4 ☐ N5 ☐ N6 ☐ Other

SECTION B (ACTUAL USE OF MOBILE DEVICES, TECHNOLOGY & INTERNET FOR LEARNING)

5. Which Mobile Learning Device Do You Own / Use?

☐ Smartphone. ☐ Tablet. ☐ Laptop. ☐ Desktop. ☐ Other Mobile devices.

6. Where Do You Access Your Internet Services?

☐ Home. ☐ Work. ☐ School / College. ☐ Internet café. ☐ Other.

7. How Do You Consider Your Technology Proficiency / Skills level?

☐ Poor. ☐ Beginner. ☐ Fair. ☐ Good. ☐ Intermediate. ☐ Advanced. ☐ Non-User.

8. Should The College Recommend the Implementation of Mobile Learning In Your Studies?

☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree.

SECTION C (FACTORS INFLUENCING STUDENTS USE OF MOBILE LEARNING)

9. This section explores whether the adoption of **Mobile Learning Technology** in higher education institutions' academic settings is influenced by the **Relative Advantage** of the technology**: Tick/ Select the applicable checkbox adjacent to the sentence.**

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
9.1. Mobile learning improves the quality of my task completion than to traditional classroom learning.	☐	☐	☐	☐	☐
9.2. Mobile learning gives me greater control over my tasks than traditional classroom learning.	☐	☐	☐	☐	☐
9.3. Mobile learning is more convenient when completing my learning tasks than traditional classroom learning.	☐	☐	☐	☐	☐

9.4. Mobile learning is quicker when accessing my learning information than traditional classroom learning.	☐	☐	☐	☐	☐
9.5. Mobile learning enhances my overall learning experiences than traditional classroom learning.	☐	☐	☐	☐	☐
9.6. Mobile learning saves me time when attending to my learning tasks than traditional classroom learning.	☐	☐	☐	☐	☐

10. This section explores whether the adoption of **Mobile Learning Technology** in higher education institutions' academic settings is influenced by the **Complexity** of the technology**: Tick/ Select the applicable checkbox adjacent to the sentence.**

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
10.1. Mobile learning needs my knowledge and understanding to use.	☐	☐	☐	☐	☐
10.2. Mobile learning needs training and technical support to use.	☐	☐	☐	☐	☐
10.3. Mobile learning is difficult and complicated to use.	☐	☐	☐	☐	☐
10.4. Mobile learning is irritating to use.	☐	☐	☐	☐	☐

11. This section explores whether the adoption of **Mobile Learning Technology** in higher education institutions' academic settings is influenced by the **Compatibility** of the technology**: Tick/ Select the applicable checkbox adjacent to the sentence.**

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
11.1. Mobile learning suits me well with the way I want to learn and complete learning tasks.	☐	☐	☐	☐	☐
11.2. Mobile learning is compatible with the mobile device I am using.	☐	☐	☐	☐	☐
11.3. Mobile learning suits my lifestyle than traditional classroom learning.	☐	☐	☐	☐	☐

12. This section explores whether the adoption of **Mobile Learning Technology** in higher education institutions' academic settings is influenced by the **Observability** of the technology**: Tick/ Select the applicable checkbox adjacent to the sentence.**

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
12.1. I have already noticed the advantages of using mobile learning.	☐	☐	☐	☐	☐
12.2. Mobile learning has transformed the way I learn and complete my tasks.	☐	☐	☐	☐	☐
12.3. I have seen the advantages of owning mobile devices through mobile learning.	☐	☐	☐	☐	☐

13. This section explores whether the adoption of **Mobile Learning Technology** in higher education institutions' academic settings is influenced by the **Trialability** of the technology**: Tick/ Select the applicable checkbox adjacent to the sentence.**

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
13.1. I need to try and test mobile learning before using it.	☐	☐	☐	☐	☐
13.2. I will use mobile learning after receiving feedback from those who are using it.	☐	☐	☐	☐	☐
13.3. I will have to first check my mobile device to see if I can use mobile learning on it.	☐	☐	☐	☐	☐

14. This section explores whether the adoption of **Mobile Learning Technology** in higher education institutions' academic settings is influenced by the **Perceived risk** of the technology**: Tick/ Select the applicable checkbox adjacent to the sentence.**

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
14.1. Using mobile learning is risky for my academic success.	☐	☐	☐	☐	☐
14.2. I fear the costs of using mobile learning.	☐	☐	☐	☐	☐
14.3. I fear using mobile learning as it risks losing my personal information.	☐	☐	☐	☐	☐

15. This section explores whether the adoption of **Mobile Learning Technology** in higher education institutions' academic settings is influenced by the **Attitude** of the end users**: Tick/ Select the applicable checkbox adjacent to the sentence.**

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
15.1. I am confident about using mobile learning through my mobile device.	☐	☐	☐	☐	☐
15.2. I like using mobile learning to complete my academic tasks.	☐	☐	☐	☐	☐
15.3. Using mobile learning is good for my academic success.	☐	☐	☐	☐	☐
15.4. I favour using mobile learning as it has changed my personal well-being.	☐	☐	☐	☐	☐

16. This section explores whether the adoption of **Mobile Learning Technology** in higher education institutions' academic settings is influenced by the **Usage Intention** of the end users**: Tick/ Select the applicable checkbox adjacent to the sentence.**

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
16.1. I am confident and intend to continue to use mobile learning for my academic tasks.	☐	☐	☐	☐	☐
16.2. I intend to use mobile learning for my future studies.	☐	☐	☐	☐	☐
16.3. I intend to tell others to use mobile learning for their studies.	☐	☐	☐	☐	☐

APPENDIX B: GATEKEEPER'S LETTER

higher education & training
Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

VHEMBE TVET COLLEGE

Central Office
Site 203, Unit A
SIBASA
LIMPOPO, 0970

Tel. (015) 963 7000
Fax (015) 963 3150/4
E-mail: info@vhembecollege.edu.za

VHEMBE T.V.E.T COLLEGE

Enq: Office of the Deputy Principal Academic Services
015 963 7000/7093

To: Mr. Makhavhu Phathutshedzo

Contact Number: 0159629305

Cell Number : 0715590025

RE: REQUEST TO CONDUCT A RESEARCH AT VHEMBE TVET COLLEGE

The above matter refers;

After review of the study protocol, Vhembe TVET College hereby grants Mr. Makhavhu Phathutshedzo permission to conduct his study at Vhembe TVET College under the following research topic: A model to implement mobile technology in higher education institutions to support digital transformation.

Approval is given with an exception that the research will be conducted without interference in the daily activities of the college.

Kind Regards.

Deputy Principal Academic Services

Mrs. Booi M

Date: 02/04/2024

APPENDIX C: PARTICIPANTS INFORMATION SHEET

UNISA university of south africa

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number:
Research permission reference number (if applicable):

Date: 24 October 2024

Title: A model to implement mobile technology in higher education institutions to support digital transformation.

Dear Prospective Participant

My name is Makhavhu Phathutshedzo and I am doing research with Dr Mampilo Phahlane a Senior lecturer in the Department of Science, Engineering and technology towards a Masters in Computing at the University of South Africa. We are inviting you to participate in a study entitled A model to implement mobile technology in higher education institutions to support digital transformation.

WHAT IS THE PURPOSE OF THE STUDY?

The purpose of this study is to investigate the use of mobile learning by students enrolled in South African higher education institutions and how such technology can significantly improve students' learning capabilities, self-confidence and academic performances. Moreover, this research will also assess the challenges experienced by students during the adoption of mobile learning by institutions as a digital transformation strategy.

WHY AM I BEING INVITED TO PARTICIPATE?

There is an increase in the number of people in possession of mobile phones in Colleges and Universities, which are being used mostly for educational purposes. Your participation in this study will provide a deeper understanding of the role of mobile technology in higher education, its potential benefits and its impact on your learning capabilities and academic performance. Your participation will also highlight your views on the impact of digital transformation in higher education institutions.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

Your role in participating in this study is to answer the questionnaire as honestly and truthfully as possible based on your experience and understanding of the concepts in question. Answering the questionnaire may take approximately 15 to 20 minutes.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Your participation in answering this study questionnaire is entirely voluntary, with no obligation to consent and be involved in participation. Should you decide to participate in this study, a consent form for your signature and this information sheet will be given to you. You are, however, free to withdraw from participating in this study at any time and without giving an explanation.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

Your contribution to this study is free as you will be assisting the researcher in understanding the role of mobile technology in South African higher education and finding out the perspectives of students with regard to their individual experiences with mobile technology in an academic environment.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR PARTICIPATING IN THE RESEARCH PROJECT?

There are no expected negative consequences for participating in this research project. Answering the questionnaire is entirely voluntary. All the rights of the participant will be respected.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

All participants' responses will be kept anonymous, and information will be kept confidential and used only for the purpose of this research project. The questionnaire only contains information about your gender, age group, and level of qualification. There is no information on the questionnaire that directly identifies an individual. The only individuals who can review the information from the questionnaire are the researcher's supervisor, research assistant, professional statistician, and UNISA ethics review committees, examiners and publications authorities.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Your complete questionnaire copies will be stored in a locked office/room to which only authorized personnel have access. Electronic copies of your record will be kept in a password-protected external drive secured in a locked office/room. According to the recordkeeping guidelines, your questionnaire will only be stored for a minimum period of 5 years; thereafter, copies will be disposed of through fire or shredding machines. Electronic copies will be permanently deleted on the computer and backup drives. Future use of data will be approved by the Research Ethics Review and approval if applicable.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

There is no expected payment for participating in this project. Your participation is entirely voluntary and free from any expected financial payment or gifts. All project costs incurred will be paid entirely by the researcher.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This research project has received written approval from the CSET Research Ethics Committee at UNISA, with a copy available from the researcher for viewing upon request.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings or require any further information or want to contact the researcher about any aspect of this study, please contact Makhavhu Phathutshedzo on **071 559 0025** or e-mail makhavp@gmail.com.

Should you have concerns about the way in which the research has been conducted, you may contact Dr Mampilo Phahlane on **074 031 3667** or email phahlmm@unisa.ac.za. Alternatively, Contact the research ethics chairperson of the SOC Research Ethics Committee at SocEthics@unisa.ac.za if you have any ethical concerns.

Thank you for taking the time to read this information sheet, and looking forward to your participation in the research project.

Kini regards



Makhavhu Phathutshedzo.

APPENDIX D: PROPOSAL ACCEPTANCE LETTER

UNISA university of south africa

1 DHR

MAKHAVHU P MR
P O BOX 9444
SHAYANDIMA
0945

STUDENT NUMBER : 5835-114-0

ENQUIRIES NAME : THULARE CD, MR
ENQUIRIES TEL : 0116709494

DATE : 2024-11-07

I have pleasure in informing you that your research proposal has been accepted. Please see details below:

DEGREE : MSC IN COMPUTING (98961)

TITLE : A model to implement mobile technology in higher education institutions to support digital transformation

SUPERVISOR : Dr MM PHAHLANE (PHAHLMM@unisa.ac.za)

CO-SUPERVISOR : Dr L MALUNGANA-MANTSHA (Lario.lalie@gmail.com)

ACADEMIC YEAR : 2024

f176 m&d PARAGRAPH

Yours faithfully,

Prof MM Sepota
Acting Registrar

UNIVERSITEIT VAN SUID-AFRIKA
PRETORIA
UNIVERSITY OF SOUTH AFRICA

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APPENDIX E: ETHICAL CLEARENCE LETTER

5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.

6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.

7. No field work activities may continue after the expiry date (05/02/2028). Submission of a completed research ethics progress report will constitute an application for renewal, for Ethics Research Committee approval.

Additional Conditions

1. Disclosure of data to third parties is prohibited without explicit consent from Unisa.
2. De-identified data must be safely stored on password protected PCs.
3. Care should be taken by the researcher when publishing the results to protect the confidentiality and privacy of the university.
4. Adherence to the National Statement on Ethical Research and Publication practices, principle 7 referring to Social awareness, must be ensured: "Researchers and institutions must be sensitive to the potential impact of their research on society, marginal groups or individuals, and must consider these when weighing the benefits of the research against any harmful effects, with a view to minimising or avoiding the latter where possible." Unisa will not be liable for any failure to comply with this principle.

Note

The reference number 3213 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Kind regards,

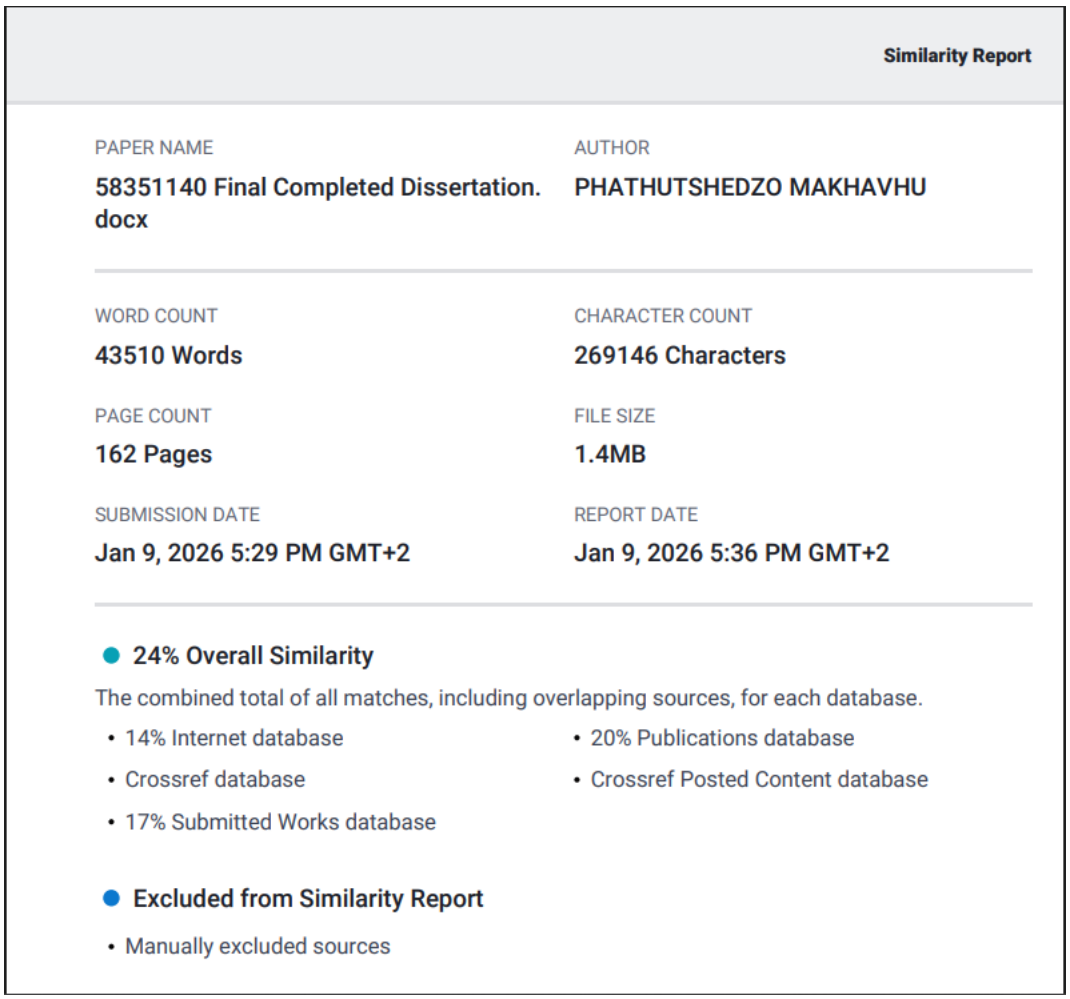


Dr. Danie Bisschoff
Chair of College of Science, Engineering and Technology_ School of Computing_ERC
E-mail: Dbischof@unisa.ac.za



Prof. SJ. Johnston
Executive Dean / By delegation from the Executive Dean of College of Science, Engineering and Technology_ School of Computing_ERC
E-mail: johnssj@unisa.ac.za

APPENDIX F: TURNITIN REPORT.



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APPENDIX G: ARTICLE UNDER REVIEW.

A multi-theoretical thematic synthesis expounding challenges influencing students' attitudes and intentions towards mobile Learning in Higher Education.

Phathutshedzo Makhavhu (Corresponding author), Mampilo Phahlane

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University of South Africa (UNISA)
Department of information systems

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Abstract.

Mobile learning is increasingly essential to higher education. However, its implementation and continued utilisation are inconsistent, especially in environments hindered by infrastructural limitations and digital inequalities. This systematic thematic review consolidates empirical research that investigates the challenges affecting students' attitudes and behavioural intentions about mobile learning in higher education. Through a PRISMA-guided screening approach, 31 peer-reviewed studies published between 2021 and 2025 were identified from Google Scholar and Scopus and evaluated using thematic synthesis. The review identifies eight interconnected categories of adoption challenges: practical educational design, institutional and managerial preparedness, technological and interface limitations, psychological and motivational constraints, socioeconomic and resource barriers, digital and AI literacy, including mental load, interoperability, integration, and compatibility issues, as well as cultural and communication factors. Although conventional adoption factors, such as perceived usefulness, ease of use, and facilitating conditions, continue to promote influence, modern research highlights new obstacles associated with AI-enhanced mobile learning, including issues of trust, fairness, and transparency, mental load, ethics, and psychological readiness. This review synthesises insights from the TAM, UTAUT, DOI, SDT, CLT, and ECM perspectives to develop a comprehensive conceptual framework. It suggests that attitudes towards AI, psychological need satisfaction, and mental load influence learning strategies such as deep versus surface learning, satisfaction, and continuous adoption. The results suggest practical implications for policy and institutional strategy, as well as educational design aspects and responsible AI integration factors, consistent with global commitments to inclusive and equitable quality education.

Keywords: Adoption, artificial intelligence, challenges, higher education, mobile learning, thematic review.