

Beyond access: Structural and pedagogical barriers to e-learning in South African higher education

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Abstract: The rapid expansion of e-learning in higher education has been widely regarded as a mechanism for enhancing access and flexibility. However, in contexts characterized by socio-economic inequality, such as South Africa, this transition has exposed persistent structural and pedagogical challenges that undermine its effectiveness. This study aimed to examine the structural barriers influencing students' access to and participation in e-learning, the pedagogical challenges affecting its effectiveness, and how these factors collectively shape students' learning experiences and outcomes within a university of technology. A qualitative research approach was employed, utilizing semi-structured interviews with 20 undergraduate students selected through purposive sampling. Data were analyzed using thematic analysis. The findings reveal that structural barriers, including limited access to reliable internet, high data costs, inadequate devices, and unconducive learning environments, significantly constrain student participation. In addition, pedagogical challenges, such as passive content delivery, limited interaction, delayed feedback, and inconsistent use of digital tools, hinder meaningful engagement. Importantly, the study demonstrates that these barriers are not isolated but mutually reinforcing, resulting in compounded disadvantages for students. The study contributes to the literature by providing a nuanced, student-centered understanding of e-learning challenges and extending theoretical perspectives on the digital divide and technology acceptance in resource-constrained contexts. It is recommended that higher education institutions adopt integrated strategies that address both infrastructural inequalities and pedagogical design to enhance the effectiveness and inclusivity of e-learning.

Keywords: *Digital divide, E-learning, Higher education, Pedagogical challenges, South Africa, Student experiences, Universities of technology.*

1. Introduction

The rapid integration of electronic learning (e-learning) within higher education has transformed teaching and learning practices worldwide, with institutions increasingly leveraging digital platforms to enhance accessibility, flexibility, and student engagement [1]. In South Africa, this transition has been both accelerated and complicated by persistent socio-economic inequalities, infrastructural limitations, and institutional disparities [2-4]. While e-learning is often heralded as a mechanism for widening access to education, emerging scholarship suggests that access alone does not guarantee meaningful participation or academic success. Instead, deeper structural and pedagogical barriers continue to shape student experiences in complex and often exclusionary ways [5].

The global shift toward online and blended learning, particularly during and after the COVID-19 pandemic, has been widely documented as a turning point in higher education. Bozkurt and Sharma [6] postulate that the emergency adoption of remote teaching exposed systemic weaknesses in institutional preparedness, especially in developing contexts. In South Africa, this shift brought to the fore pre-existing inequalities rooted in the digital divide, with students from disadvantaged backgrounds

disproportionately affected [3]. Thus, the assumption that technological provision equates to educational equity has been increasingly contested.

Existing literature has established that e-learning effectiveness is contingent upon a range of interrelated factors, including technological infrastructure, digital literacy, pedagogical design, and institutional support. Researchers such as Czerniewicz et al. [7] opine that the higher education landscape is characterized by “unevenness,” where historically disadvantaged institutions and students face compounded challenges in adapting to digital learning environments. Similarly, Mhlanga and Moloi [8] stress that issues such as high data costs, unreliable internet connectivity, and limited access to appropriate devices remain significant impediments to effective e-learning.

However, beyond these structural constraints, pedagogical barriers also play a critical role in shaping student outcomes. The literature increasingly posits that the mere digitization of content does not constitute effective online learning. Instead, meaningful engagement requires intentional instructional design, interactive learning strategies, and ongoing academic support. Building pedagogical patterns for learning and technology. Teaching as a Design Science. Building pedagogical patterns for learning and technology. Teaching as a Design Science Laurillard [9]; Bergdahl [10]; Molokomme and Mahlakwana [3]. Theelen and van Breukelen [11] postulate that effective e-learning must be underpinned by dialogic and interactive pedagogies that facilitate active knowledge construction. In contrast, the replication of traditional lecture-based approaches in virtual environments often results in passive learning experiences, thereby undermining student engagement and success.

Furthermore, student readiness for e-learning has emerged as a critical yet often overlooked dimension. Studies have established that many students, particularly those in Universities of Technology, enter higher education with varying levels of digital competence and self-regulated learning skills [12, 13]. This disparity is further exacerbated by socio-economic conditions that influence students’ learning environments, including overcrowded households and limited access to quiet study spaces [14]. Consequently, the challenges associated with e-learning extend beyond institutional provision to encompass broader contextual realities that shape students’ ability to participate effectively [15].

Against this backdrop, this study seeks to move beyond the dominant discourse of access and interrogate the structural and pedagogical barriers that continue to constrain e-learning in South African higher education [3, 11]. While prior research has largely focused on issues of access to devices and connectivity, there remains a need for a more nuanced understanding of how these factors intersect with pedagogical practices and student experiences. This study, therefore, posits that addressing e-learning challenges requires a holistic approach that considers not only technological provision but also the quality of teaching, institutional support mechanisms, and the broader socio-economic context within which learning occurs.

In doing so, the study seeks to contribute to the ongoing debates on digital transformation and educational equity by foregrounding the lived experiences of students within a University of Technology setting. It is argued that without deliberate efforts to address both structural and pedagogical barriers, e-learning initiatives risk reproducing and potentially exacerbating existing inequalities in higher education [16]. The study thus aims to provide empirically grounded insights that can inform policy, practice, and future research in the evolving landscape of digital education.

2. Problem Statement

Despite the widespread adoption of e-learning in higher education, significant challenges persist that undermine its effectiveness, particularly within the context of South Africa. While institutions have made notable progress in expanding access to digital platforms and learning management systems, scholarship consistently posits that access alone does not translate into meaningful participation or improved academic outcomes. The abrupt transition during the COVID-19 pandemic exposed entrenched structural inequalities, as many students continued to face barriers such as limited access to reliable internet connectivity, unaffordable data, inadequate digital devices, and unconducive home

learning environments. Czerniewicz et al. [7] established that these disparities are deeply embedded within broader socio-economic inequalities that characterize the South African higher education system. In a similar vein, Mhlanga and Moloji [8] stress that infrastructural deficits and uneven institutional preparedness have significantly constrained the effective implementation of e-learning. These realities collectively challenge the assumption that technological provision equates to educational equity, thereby calling into question the transformative potential of e-learning in historically unequal contexts.

Beyond structural constraints, pedagogical limitations further exacerbate the effectiveness of e-learning. The literature postulates that the rapid shift to online learning resulted in the replication of traditional, lecture-based teaching approaches within digital environments, often without adequate pedagogical redesign. Mansour [17] opines that this phenomenon reflects a reliance on “emergency remote teaching” rather than carefully structured online learning, ultimately compromising student engagement and learning quality. Furthermore, Laurillard [9] emphasizes that effective e-learning is predicated on interactive, student-centered pedagogies that promote active knowledge construction, an ideal that remains difficult to achieve in under-resourced settings. Compounding these challenges is the issue of student readiness, as many learners lack the requisite digital competencies and self-regulated learning skills necessary for success in online environments. Against this backdrop, critical questions arise regarding the nature and extent of barriers that students encounter.

This study is therefore guided by the following research questions: (1) What structural barriers influence students’ access to and participation in e-learning at a University of Technology in South Africa? (2) What pedagogical challenges affect the effectiveness of e-learning in this context? (3) How do these structural and pedagogical barriers collectively shape students’ learning experiences and outcomes?

By addressing these questions, the study seeks to provide a nuanced understanding of the multifaceted challenges that extend beyond access, thereby contributing to more inclusive and contextually responsive e-learning practices.

3. Theoretical Framework

This study is underpinned by a combination of theoretical perspectives that collectively provide a comprehensive lens for understanding the structural and pedagogical barriers to e-learning in higher education. Central to this inquiry is the Digital Divide Theory, which posits that inequalities in access to information and communication technologies are multidimensional and extend beyond mere physical access to include disparities in skills, usage, and outcomes. Scholars such as Van Dijk [18] postulate that the digital divide operates across successive levels, beginning with access to devices and connectivity, and extending to digital competencies and the ability to derive meaningful benefits from technology use. Similarly, Van Deursen and Van Dijk [19] further established that contemporary digital inequality is increasingly shaped by differences in material access and digital skills, rather than mere connectivity. Within the context of South Africa, this theory is particularly relevant as it foregrounds the structural inequalities that continue to disadvantage students from low socio-economic backgrounds, thereby limiting their effective participation in e-learning environments.

Complementing this perspective is the Technology Acceptance Model (TAM), originally developed by Davis [20], which provides insight into the factors influencing students’ adoption and use of e-learning technologies. The model posits that perceived usefulness and perceived ease of use are key determinants of technology acceptance and utilization. In the context of this study, TAM is instrumental in explaining how students’ attitudes toward e-learning platforms are shaped not only by accessibility but also by their experiences of usability, system design, and institutional support. Venkatesh et al. [21] further extended this framework through the Unified Theory of Acceptance and Use of Technology (UTAUT), emphasizing the role of social influence and facilitating conditions in shaping technology adoption. These perspectives collectively stress that students’ engagement with e-learning is not automatic but is mediated by both individual perceptions and contextual factors.

In addition to technological considerations, this study draws on Constructivist Learning Theory, which emphasizes the active role of learners in constructing knowledge through interaction, collaboration, and engagement. Vygotsky [22] postulated that learning is inherently social and occurs through interaction within a supportive environment, while Piaget [23] emphasized the importance of cognitive development and active engagement in the learning process. In the context of e-learning, these theoretical insights underscore the importance of student-centered pedagogies that facilitate interaction and meaningful engagement. Laurillard [9] further stresses that effective digital learning environments must promote dialogue, feedback, and iterative learning processes. The absence of such pedagogical elements, particularly in under-resourced contexts, often results in passive learning experiences that undermine student success.

Collectively, these theoretical frameworks provide a robust foundation for analyzing the interplay between structural inequalities, technological adoption, and pedagogical practices in e-learning. The Digital Divide Theory foregrounds systemic inequities, the Technology Acceptance Model elucidates students' engagement with technology, and Constructivist Learning Theory highlights the pedagogical conditions necessary for effective learning. By integrating these perspectives, this study posits that the challenges associated with e-learning are not isolated but are deeply interconnected, requiring a holistic and contextually responsive approach to addressing barriers in higher education.

4. Literature Review

The discourse on e-learning in higher education has expanded significantly over the past decade, with scholars interrogating its potential to enhance access while simultaneously cautioning against its unintended consequences. Within the context of South Africa, the literature overwhelmingly posits that structural barriers remain a fundamental constraint to students' access to and participation in e-learning. Literature collectively establishes that access to devices, stable connectivity, and affordable data remains unevenly distributed, particularly among students from historically disadvantaged backgrounds [7, 24, 25]. While these scholars converge on the centrality of the digital divide, they differ in analytical emphasis. Azam et al. [26] postulate a staged model of access, moving from physical access to skills and usage. Whereas Van Deursen and Van Dijk [19] refine this by stressing material access and digital competencies as contemporary determinants of inequality. Czerniewicz et al. [7], drawing on the South African context, foreground institutional disparities and systemic inequities. While Selwyn [27] critically opines that technological interventions often obscure deeper socio-economic inequalities embedded within higher education systems. However, despite the robustness of these insights, a key methodological limitation across these studies lies in their reliance on macro-level analyses and large-scale survey data, which, while valuable for identifying trends, often fail to capture the micro-level realities and lived experiences of students within specific institutional contexts such as Universities of Technology. This limitation underscores the need for contextually grounded research that interrogates how structural barriers manifest in particular settings.

In addition to structural constraints, the literature extensively engages with pedagogical challenges that influence the effectiveness of e-learning. Scholars collectively postulate that effective e-learning is contingent upon well-designed pedagogical frameworks that prioritize interaction, engagement, and alignment between learning outcomes, teaching strategies, and assessment Hodges et al. [28]; Laurillard [9]; Srikanth [29]; Edumadze and Govender [30]. Hodges et al. [28] distinguish between emergency remote teaching and authentic online learning, arguing that the former lacks pedagogical intentionality. Molokomme and Mahlakwana [3] emphasize dialogic and collaborative learning processes. While Naz et al. [31] provide empirical evidence supporting the effectiveness of blended learning approaches. In contrast, Gunde et al. [32] advance the principle of constructive alignment, stressing coherence between curriculum components. Mansour [33] highlights the importance of structured facilitation in online environments. Despite these complementary perspectives, tensions emerge regarding their applicability in resource-constrained contexts. Many of these models assume stable infrastructure, low student-to-lecturer ratios, and high levels of digital literacy, conditions often

absent in developing contexts. Methodologically, much of this work is derived from experimental, quasi-experimental, or meta-analytic studies conducted predominantly in the Global North, limiting their generalizability to contexts such as South Africa. Furthermore, there is a tendency to prioritize instructional design over contextual realities, resulting in a partial understanding of pedagogical effectiveness in diverse educational settings.

The literature further posits that structural and pedagogical barriers do not operate in isolation but are deeply intertwined, collectively shaping students' learning experiences and outcomes. It is stressed that students' engagement with e-learning is mediated by a complex interplay of technological access, institutional support, motivation, and pedagogical design Selwyn [27]; Czerniewicz et al. [7] and Mhlanga and Moloi [8]. Buraimoh et al. [34], through the UTAUT framework, emphasize the role of facilitating conditions and social influence. While Ude [35] underscores the importance of academic and social integration for student success. Catalano et al. [36] highlight disparities in online learning outcomes, particularly among underprepared students. Bozkurt and Sharma [6] stress the systemic disruptions caused by the pandemic. Selwyn [27], adopting a critical stance, argues that e-learning can reinforce exclusion if underlying inequalities are not addressed, a view that resonates with the findings of Molokomme and Mahlakwana [3] in the South African context. However, a critical evaluation of this body of work reveals persistent methodological gaps. Many studies adopt cross-sectional designs, thereby limiting their ability to capture the evolving and dynamic nature of students' experiences over time. Additionally, there is a tendency to examine structural and pedagogical factors in silos, rather than through integrated frameworks that reflect their interdependence. Qualitative, student-centred studies that foreground lived experiences remain relatively limited, particularly within Universities of Technology. This gap is significant, as it constrains the development of contextually relevant interventions aimed at improving e-learning outcomes. Consequently, this study seeks to address these limitations by providing a nuanced, empirically grounded analysis of how structural and pedagogical barriers intersect to shape students' participation, engagement, and success in e-learning environments within a South African University of Technology.

Additionally, a more critical synthesis of the literature reveals that structural and pedagogical barriers do not merely coexist but interact in ways that are mutually reinforcing, thereby compounding their impact on students' learning experiences and outcomes. Eze et al. [37] postulate that facilitating conditions, such as access to reliable infrastructure, institutional support, and technological resources, directly influence the extent to which pedagogical strategies can be effectively implemented. In contexts where students experience limited access to devices, unstable connectivity, or high data costs, even well-designed pedagogical interventions may fail to achieve their intended outcomes, as participation becomes irregular and engagement inconsistent [3]. Conversely, pedagogical shortcomings, such as poorly structured content, limited interaction, and inadequate feedback mechanisms, can exacerbate the disadvantages faced by students already constrained by structural limitations Molokomme [15]. Czerniewicz et al. [7] and Mhlanga and Moloi [8] collectively stress that in the South African context, these dynamics are particularly pronounced, as socio-economic inequalities intersect with uneven institutional capacities, resulting in differentiated learning experiences among students.

Furthermore, the interaction between structural and pedagogical barriers can be understood as a cyclical and compounding process rather than a linear relationship. Students who lack consistent access to digital tools and stable learning environments are less likely to fully engage with interactive and student-centered pedagogies, which in turn limits the development of digital literacy and self-regulated learning skills required for success in e-learning environments Pandey et al. [38]. Laurillard [9] posits that meaningful learning in online environments depends on sustained interaction, feedback, and cognitive engagement. However, such pedagogical conditions presuppose a baseline level of structural accessibility that is not uniformly available. As a result, students' experiences of e-learning are shaped by an interplay of constraints that simultaneously limit access to content and the ability to engage with it meaningfully [15]. This interaction suggests that addressing e-learning challenges requires

integrated interventions that consider both infrastructural inequalities and pedagogical design, rather than treating them as isolated issues.

5. Methodology

This study adopted a qualitative research approach to explore the structural and pedagogical barriers to e-learning experienced by students at a university of technology in South Africa. A qualitative design was deemed appropriate as it allows for an in-depth understanding of participants' lived experiences, perceptions, and challenges, rather than merely quantifying phenomena [39]. The study utilized semi-structured interviews as the primary data collection method, enabling participants to articulate their experiences in their own words while allowing the researcher to probe emergent themes and clarify responses [40]. The sample consisted of 20 undergraduate students, selected through purposive sampling to ensure representation across different faculties, years of study, and socio-economic backgrounds. Purposive sampling was justified as it prioritizes information-rich cases that can provide deep insights into the phenomenon under investigation [41]. Data collection continued until data saturation was achieved, indicated by the point at which no new themes or insights were emerging from subsequent interviews [42], ensuring the richness and completeness of the dataset.

For data analysis, the study employed thematic analysis, following the six-step framework outlined by Braun and Clarke [43], which includes familiarization, coding, theme development, reviewing, defining, and reporting. Thematic analysis was selected because it provides a systematic and flexible method for identifying patterns and relationships within qualitative data, allowing for both descriptive and interpretive insights [44]. The process was iterative and reflexive, ensuring that themes were grounded in participants' experiences while also being interpreted in light of relevant theoretical frameworks, including the Digital Divide Theory, Technology Acceptance Model, and Constructivist Learning Theory. Trustworthiness of the study was ensured through strategies such as member checking, peer debriefing, and maintaining an audit trail of analytical decisions [45]. Overall, this methodology enabled the study to generate a nuanced and contextually grounded understanding of how structural and pedagogical barriers interact to shape students' participation, engagement, and success in e-learning environments.

Table 1.
Demographic Profile of Participants.

Variable	Category	Frequency (n=20)
Gender	Male	11
	Female	9
Year of Study	First Year	0
	Second Year	0
	Third Year	5
	Fourth Year	15
Faculty	Engineering	6
	Management Sciences	5
	Human Sciences	5
	Applied Sciences	4
Access to the Internet	Mobile Data	14
	Home Wi-Fi	4
	Institutional Access	2
Device Ownership	Smartphone Only	9
	Laptop (Personal)	7
	Shared Device	4
Residence	Urban	6
	Township	9
	Peri-urban/Rural	5

The demographic profile indicates a diverse sample of students across faculties and academic levels within a University of Technology in South Africa. A significant proportion of participants relied on mobile data (n=14) and smartphones (n=9) as their primary means of accessing e-learning, highlighting potential constraints in engaging with data-intensive platforms. Additionally, the majority of students resided in township and peri-urban areas, which are often associated with infrastructural and socio-economic challenges. This distribution is critical in contextualizing the findings, as it underscores the uneven access to resources that shape students' experiences of e-learning.

6. Findings

Theme 1: Structural Barriers to Access and Participation

Participants' accounts revealed deeply entrenched structural challenges that constrained meaningful engagement with e-learning. Issues of connectivity, affordability of data, and lack of appropriate devices were consistently emphasized. Many students described their experiences in raw and emotive terms, reflecting frustration and exclusion:

"Data is very expensive, and sometimes I must choose between buying food and buying data for school." (Participant 4)

"The network where I stay is very poor, so even if I have data, I struggle to attend classes properly." (Participant 6)

"I only use my phone, and it is not easy to type assignments or download big files." (Participant 11)

"Sometimes I miss tests because my connection just disappears." (Participant 1)

Beyond technological access, participants highlighted the influence of their home environments:

"At home, there is noise all the time, children playing, TV on, so I cannot focus." (Participant 7)

"I share a room with my siblings, so there is no quiet space to study." (Participant 10)

These excerpts illustrate that structural barriers are not isolated to connectivity but extend to socio-economic and environmental conditions, which collectively limit students' ability to participate consistently in e-learning.

Theme 2: Pedagogical Challenges in E-Learning Delivery

Students' experiences further revealed significant shortcomings in the design and delivery of online teaching. A dominant concern was the passive nature of learning, with limited interaction and support from lecturers:

"Most lecturers just upload slides and expect us to understand everything ourselves." (Participant 2)

"There is no proper explanation; you just read and try to figure it out alone." (Participant 5)

"Online classes feel one-sided, like you are just listening and not really learning." (Participant 15)

Participants also expressed dissatisfaction with feedback and assessment practices:

"We submit assignments, but feedback takes too long, or sometimes we don't get it at all." (Participant 9)

"Tests are stressful because sometimes the system crashes or time runs out while you are still trying to connect." (Participant 12)

In addition, inconsistencies in lecturers' digital competence were highlighted:

"Some lecturers don't know how to use the system properly, and it confuses us." (Participant 8)

These findings suggest that pedagogical practices were not sufficiently adapted to the online environment, resulting in limited engagement, reduced clarity, and increased student frustration.

Theme 3: Interaction Between Structural and Pedagogical Barriers

A critical finding of the study is how structural and pedagogical barriers intersect to create compounded challenges. Students indicated that limited access made it difficult to benefit from already constrained pedagogical approaches:

"Even if the lecturer explains, I miss parts because my connection keeps cutting." (Participant 6)

"If you don't attend the live class, there is nothing to help you catch up properly." (Participant 13)

"Assignments have strict deadlines, but sometimes you cannot submit due to network problems." (Participant 14)

These experiences highlight how inflexible teaching practices intensify the effects of structural constraints. Conversely, a few participants who reported better access and lecturer support described more positive experiences:

“When the lecturer records sessions and explains properly, it becomes easier even if you miss the class.” (Participant 16)

This demonstrates that structural and pedagogical factors are interdependent, and addressing one without the other is insufficient.

Theme 4: Student Agency and Self-Regulated Learning

While many challenges were identified, some students demonstrated resilience and adaptive strategies to navigate e-learning:

“I download everything when I have Wi-Fi on campus, then study later offline.” (Participant 3)

“I ask my classmates on WhatsApp if I don’t understand something.” (Participant 18)

“I try to manage my time, but it is not always easy with everything happening at home.” (Participant 20)

However, not all students were able to adopt such strategies:

“It is hard to stay motivated when you are struggling with everything at once.” (Participant 17).

These findings indicate that while individual effort can mitigate some challenges, it does not fully compensate for structural and pedagogical deficiencies. Students’ ability to succeed in e-learning environments is therefore uneven and influenced by a combination of personal capacity, access to resources, and the quality of instructional support.

7. Discussions

The findings of this study provide strong empirical support for the Digital Divide Theory, as advanced by Van Dijk [18] and further refined by Van Deursen and Van Dijk [19]. Consistent with these scholars, the study established that inequalities in e-learning are not limited to access to devices and connectivity but extend to issues of affordability, learning environments, and digital competencies. Participants’ reliance on mobile data, shared devices, and unconducive home environments confirms the existence of second- and third-level digital divides, thereby reinforcing the argument that access alone is insufficient for meaningful participation. These findings are also highly consistent with the South African-focused work of Czerniewicz et al. [7], who stress that structural inequalities are deeply embedded within the higher education system. However, while existing studies largely rely on macro-level analyses, the present study extends the literature by providing micro-level, lived experiences, thereby addressing a key methodological limitation identified in prior research. In this regard, the findings do not contradict the literature but rather deepen and contextualize it.

Regarding the TAM developed by Davis [20] and extended by Venkatesh et al. [21], the findings demonstrate that students’ engagement with e-learning is significantly influenced by perceived usefulness and ease of use. Participants’ frustrations with unstable platforms, high data costs, and poorly structured online content suggest that both constructs are negatively affected in this context. This aligns with the literature, especially studies emphasizing facilitating conditions and institutional support as key determinants of technology adoption. However, the findings also reveal a partial inconsistency with TAM’s core assumption that users’ perceptions primarily drive adoption. In this study, structural constraints, such as lack of access and affordability, often override individual perceptions, indicating that in resource-constrained contexts like South Africa, technology acceptance is less a matter of choice and more a function of necessity and constraint. This extends TAM by highlighting the dominance of structural factors over individual agency in shaping technology use.

The findings align strongly with Constructivist Learning Theory, particularly the work of Vygotsky [22], Piaget [23], and Laurillard [9], all emphasizing interaction, engagement, and active knowledge construction as central to effective learning. Participants’ experiences of passive content delivery, limited interaction, and delayed feedback indicate a clear absence of these pedagogical principles in practice. This aligns with the critique by Hodges et al. [28], who distinguish between

emergency remote teaching and well-designed online learning. However, the findings also reveal a critical gap between theory and practice, as pedagogical models in the literature often assume conditions like stable connectivity and high digital literacy, which are not present in this context. Thus, while the study confirms the validity of constructivist principles, it also highlights their limited applicability in under-resourced environments lacking adequate structural support.

In relation to the broader literature, the findings are largely consistent with studies on structural barriers, including those by Czerniewicz et al. [7], Posselt et al. [24] and Huang et al. [25], which collectively establish that access to technology and connectivity remains uneven. Similarly, the findings align with Selwyn [27], who opines that technological interventions often obscure deeper socio-economic inequalities. However, this study advances the literature by demonstrating how these inequalities are experienced in practice, particularly within a University of Technology context, thereby addressing the lack of qualitative, student-centred research highlighted in prior studies.

Regarding pedagogical challenges, the findings are consistent with the literature that critiques the lack of instructional design and interaction in e-learning environments [9, 28, 30]. The predominance of passive teaching methods reported by participants supports the argument that many institutions adopted emergency measures rather than pedagogically sound approaches. However, there is some inconsistency with studies reporting positive outcomes associated with well-designed online and blended learning [31], suggesting such outcomes may not be easily replicable in resource-constrained contexts. This discrepancy highlights the importance of contextual factors, particularly infrastructure and institutional capacity, in determining the effectiveness of pedagogical models.

Most critically, the findings provide strong empirical support for the literature that emphasizes the interaction between structural and pedagogical barriers [6, 8, 27]. Consistent with Bozkurt and Sharma [6], the study demonstrates that disruptions in access directly affect students' ability to engage with learning activities. Similarly, the findings align with studies grounded in UTAUT, which stress the importance of facilitating conditions in shaping engagement. However, this study extends the literature by illustrating that this interaction is not merely additive but compounding and cyclical. Structural constraints limit access to pedagogical opportunities, while inadequate pedagogical design further marginalizes students already disadvantaged by structural barriers. This supports the argument by Eze et al. [37] and Molokomme [15] that effective e-learning requires the alignment of infrastructure and pedagogy.

Finally, the findings reveal a partial inconsistency with the literature that emphasizes student agency and self-regulated learning as key determinants of success [38]. While some participants demonstrated adaptive strategies, the majority struggled due to overwhelming structural and pedagogical constraints. This suggests that while self-regulation is important, it cannot compensate for systemic deficiencies. Consequently, the study challenges the implicit assumption in some literature that student success in e-learning is primarily an individual responsibility, instead positing that it is fundamentally shaped by structural and institutional conditions.

Therefore, the findings confirm, extend, and in some cases challenge existing theoretical and empirical literature. They reinforce the validity of the Digital Divide Theory, partially extend the Technology Acceptance Model, and confirm the principles of Constructivist Learning Theory, while simultaneously highlighting the contextual limitations of their application. Most importantly, the study contributes to the literature by demonstrating that structural and pedagogical barriers are deeply interconnected, requiring integrated and contextually responsive interventions to enhance the effectiveness of e-learning in higher education.

8. Conclusion and Recommendations

This study aimed to examine the structural and pedagogical barriers to e-learning at a University of Technology in South Africa, focusing on how these factors influence students' access, participation, and overall learning experiences. Guided by three research questions, the study sought to investigate (1) the structural barriers affecting access, (2) the pedagogical challenges shaping effectiveness, and (3) the

interaction between these barriers in influencing student outcomes. The findings demonstrate that while e-learning has been positioned as a transformative tool for expanding access to higher education, its implementation within this context remains uneven and deeply constrained by persistent socio-economic inequalities and limitations in pedagogical design.

The study revealed that structural barriers, particularly limited access to reliable internet, high data costs, inadequate devices, and unconducive home environments, continue to significantly hinder students' participation in e-learning. These challenges are not isolated but are embedded within broader systemic inequalities that shape students' ability to engage meaningfully with digital learning platforms. In parallel, pedagogical shortcomings, including passive content delivery, limited interaction, delayed feedback, and inconsistent use of digital tools by lecturers, further undermine the effectiveness of e-learning. Importantly, the study established that these structural and pedagogical barriers are interdependent and mutually reinforcing, creating compounded disadvantages for students. This interaction highlights that addressing e-learning challenges requires more than isolated interventions; rather, it necessitates a holistic and integrated approach that considers both access and instructional design.

This study makes several important contributions to both theory and practice. Theoretically, it reinforces the relevance of Digital Divide Theory by demonstrating that inequalities in e-learning extend beyond access to include issues of affordability, digital skills, and learning environments. It also extends the Technology Acceptance Model by illustrating that, in resource-constrained contexts, technology use is shaped less by individual perceptions and more by structural conditions. Furthermore, the study confirms the applicability of Constructivist Learning Theory while exposing the gap between pedagogical ideals and actual practice in under-resourced settings.

Empirically, the study contributes to the literature by providing rich, qualitative, student-centered insights into the lived experiences of e-learning, thereby addressing the methodological limitations of prior research that has largely relied on quantitative and macro-level analyses. By foregrounding the voices of students within a University of Technology, the study offers a nuanced understanding of how structural and pedagogical barriers intersect in practice. Methodologically, the study advances research in this area by demonstrating the value of qualitative approaches in capturing the complexity and contextual specificity of e-learning challenges. Practically, the findings provide evidence-based insights that can inform institutional strategies, policy development, and teaching practices aimed at improving the effectiveness and inclusivity of e-learning in higher education.

In light of the findings, several recommendations are proposed to enhance the effectiveness of e-learning in higher education. First, there is a need for institutional investment in infrastructure and access support. Universities should prioritize the provision of affordable or subsidized data packages, expand access to loan devices, and strengthen on-campus and remote connectivity solutions. Such interventions are critical in addressing the structural inequalities that continue to limit student participation.

Secondly, institutions must focus on strengthening pedagogical practices in e-learning environments. This includes providing continuous professional development for lecturers on digital pedagogy, instructional design, and the effective use of online platforms. Emphasis should be placed on creating interactive, student-centered learning experiences that promote engagement, collaboration, and timely feedback. Additionally, teaching approaches should incorporate flexibility, such as asynchronous learning options and recorded lectures, to accommodate students facing connectivity challenges.

Thirdly, there is a need to enhance student support and capacity-building initiatives. Universities should implement programs aimed at developing students' digital literacy and self-regulated learning skills, enabling them to navigate online learning environments more effectively. Peer support systems, online learning communities, and accessible academic support services can further assist students in overcoming challenges associated with e-learning.

Finally, policymakers and institutional leaders should adopt a holistic and integrated approach to e-learning implementation. This involves recognizing the interconnected nature of structural and

pedagogical barriers and designing interventions that address both simultaneously. Without such an approach, efforts to improve e-learning are likely to remain fragmented and insufficient.

In conclusion, while e-learning holds significant potential to transform higher education, its success in contexts such as South Africa depends on addressing the complex and interrelated challenges identified in this study. By prioritizing equity, pedagogical innovation, and contextual responsiveness, institutions can move beyond access toward more meaningful and inclusive digital learning experiences.

Institutional Review Board Statement:

Ethical clearance for this study was obtained from the relevant Faculty Research Ethics Committee. The study adhered to established ethical principles, including voluntary participation, informed consent, confidentiality, and anonymity of participants. Participants were informed of their right to withdraw from the study at any stage without any negative consequences. All data were securely stored and used strictly for academic purposes. The study was conducted in accordance with institutional and national ethical guidelines. Ethics Clearance Number: FREC/HS/24/03/2023/6.1.11

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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