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Article

Assessing the Impact of Technology Access and Equity in Open Distance e-Learning

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Abstract

The rise of open distance e-learning (ODEL) has transformed the landscape of higher education, offering flexible learning opportunities to student-teachers to pursue academic programs without constraints. Literature shows an increasing adoption of ODeL models in higher education to expand access. However, despite the expansion of ODeL, deep-rooted inequalities in technological access remain a pressing concern, particularly for student-teachers in rural and historically disadvantaged communities. Therefore, the current study aimed to assess the impact of technology access and equity on student-teachers' learning in ODeL to inform more inclusive and context-sensitive policy and practice. Grounded in the digital divide framework, the study examined how access to technologies influences opportunities for participation in the digital age. This study adopted a qualitative approach with semi-structured interviews with student-teachers to understand their views on these issues. Data were analyzed using thematic analysis, with results revealing that some student-teachers do not own personal digital devices and depend on shared campus access. On the other hand, unlike this group, student-teachers with a stable Internet connection and their own devices can access materials, attend virtual classes, and even meet academic deadlines. If these inequities are not addressed, implementing ODeL may inadvertently widen the educational divide.

Keywords: equity gaps; inequities; digital methods; connectivity; student-teachers; digital technologies; open distance e-learning

1. Introduction

Open distance e-learning (ODEL) has significantly transformed the higher education landscape, particularly in response to the COVID-19 pandemic and the growing digitization of education [1–3]. These digital technologies are essential tools to enhance and extend pedagogical approaches, fostering increased motivation, engagement, study skills, and overall achievement among student-teachers [4]. This means that ODeL merges the flexibility of open learning with the accessibility of distance education, enabling student-teachers to pursue academic programs irrespective of time, location, or personal circumstances. Literature indicates that this learning model is increasingly vital in contexts marked by geographical dispersion, socioeconomic inequalities, or resource limitations, where traditional face-to-face instruction may be impractical or unattainable [5]. While this model holds the potential for inclusivity and the democratization of education, scholars argue [6–8] that its effectiveness depends on student-teachers acquiring the necessary digital competencies to engage with emerging tools and content. Furthermore, concerns regarding equitable access to technology remain pressing [9].

Despite these advancements facilitating access to education, challenges persist, including the disparities in access to resources and the achievement gap, highlighting the differences in academic performance [10]. This study sought to critically assess the impact of technology access and equity on student-teachers' learning in South African ODeL institutions to inform more inclusive and context-sensitive policy and practice. It explored the intersection of technology, pedagogy, and

policy, analyzing how institutional efforts can bridge or widen the equity gap among student-teachers. By examining systemic and individual dimensions, the research aimed to inform more inclusive practices in digital education in South African institutions.

Research Questions

The study aimed to respond to the following research questions:

1. What are the patterns and disparities in digital access among university student-teachers regarding device ownership, Internet connectivity, and digital literacy?
2. What institutional strategies are in place to promote digital equity?

2. Literature Review

2.1. Conceptual Framework

This study is grounded in van Dijk's theory of the digital divide [11]. According to van Dijk [11], the digital divide resulted from social and economic gaps, including access, usability, and empowerment. van Dijk [11] conceptualized digital access as a multi-dimensional phenomenon that includes, first, motivational access, which refers to the willingness and motivation to use digital technologies. Secondly, material access refers to physical access to devices and an Internet connection and, thirdly, skills, access, digital skills, and competencies. Lastly, it involves using access, which is applying digital tools effectively in daily life and education. This theory helps analyze whether students have access, how they access it, what they do with it, and the structural conditions shaping their engagement. The theory is relevant to the study in that when students lack motivation (mental access), they may resist engaging with educational technology, regardless of Internet availability. It also stipulates that without adequate infrastructure (devices, Internet), especially in under-resourced schools, e-learning efforts fail or disproportionately disadvantage specific learners, especially those who do not have access. Educational equity requires student-teachers (and instructors) to possess not just basic tech competence, but higher-order skills, such as effectively searching for information, critically evaluating content, and using digital tools strategically. Integration across curricula, and not isolated computer classes, is essential. Therefore, socioeconomic, cultural, and institutional factors shape who is motivated and who has access, skills, and opportunities related to digital technologies.

2.2. Defining the Digital Divide in Teacher Education

Recent literature clarifies what is meant by digital access and equity in the context of distance and open learning. The digital divide refers to the gap between those with access to and use of technology and those without access [12–14]. It is characterized by differences in access to technology and digital resources, which create inequities and hinder learning opportunities [15]. In the context of teacher education, digital access extends far beyond the mere possession of devices or Internet connectivity because it relates to the quality of that access, including bandwidth reliability, data affordability, and technical support availability [16]. This gap can be attributed to a variety of factors, such as income, education level, geographic location, and age. Digital equity involves various interconnected dimensions that include access to devices and the Internet, skills to use digital tools effectively, and supportive learning environments that foster engagement with technology [12,17]. This leads to barriers that limit institutions from effectively operating ODeL, and these are discussed below.

2.3. Access to Technology in ODeL

The patterns of digital access among student-teachers have significant implications for their learning, digital competence development, and future teaching practices. Literature shows that access does not simply refer to having physical tools such as laptops and smartphones, but includes Internet

bandwidth, device quality, digital skills, and consistent electricity supply [18]. Mpungose [19] supports the notion that while most student-teachers have access to mobile phones, access to laptops and computers is uneven, with rural and low-income students being the most disadvantaged. This means there is an access gap among student-teachers. Some of them are limited in accessing learning materials that might be uploaded, resulting in the digital divide. Unequal digital access to online learning creates digital barriers by causing differing levels of digital competence among student-teachers. This started during the COVID-19 pandemic, when device ownership was a significant barrier for disadvantaged student-teachers, prompting many universities to loan devices or rely on mobile-friendly platforms [20]. While online learning has expanded educational opportunities, it amplifies pre-existing inequalities among student-teachers. Ng'ambi et al. [21] further support the notion that Internet connectivity remains a significant issue in sub-Saharan Africa, where most student-teachers rely on costly mobile data and unstable networks, restricting their ability to engage in online learning consistently. This means continued reliance on mobile devices and unstable Internet connections could have pedagogical implications for the design of ODeL programs. Brown and Czerniewicz [22] also highlight that there is an urban-rural divide in South Africa, with student-teachers in rural universities experiencing frequent disruptions due to poor bandwidth and limited infrastructure. Unstable internet connectivity and lack of digital tools negatively impacted on who relied on mobile phones or shared devices, especially during online assessments [23].

On the other hand, the time student-teachers spend online is minimal due to the location of their home or campus. Student-teachers with limited access may struggle using learning management systems (LMSs), educational tools, and content-creation tools for their digital portfolios. Le Roux [24] notes that many student-teachers in distance education have limited training in LMSs and lack access to technology and connectivity. These are among the factors contributing to high drop-out rates and poor academic performance.

2.4. Equity and Inclusion Gaps

Technology access in ODeL encompasses a broader spectrum of considerations, including affordability of Internet services, availability of technical support, usability of platforms for differently abled students, and the capacity of institutions to provide inclusive digital infrastructure. It is deeply intertwined with socioeconomic status, gender, disability, and geographic location [25]. Mhlanga [26] argues that rural student-teachers face geographic disparities due to weaker infrastructure, while urban student-teachers, on the other hand, tend to benefit from better connectivity and institutional support. Several studies have emphasized that student-teachers from low-income households are less likely to own digital tools or have reliable access, resulting in exclusion from meaningful participation [27,28]. As urban-based institutions often benefit from reliable infrastructure, student-teachers in remote or underdeveloped areas frequently face unstable or limited Internet access [21]. This causes inequalities among student-teachers, affecting their performance. These discrepancies hinder participation in online learning, especially during crises such as the COVID-19 pandemic, which exposed and deepened existing inequalities [20]. These limited digital literacy developments disadvantaged student-teachers in their engagement in ODeL environments.

2.5. Online Assessment and Digital Justice

Recent literature has also highlighted how technology mediates assessment, especially under scrutiny. Assessment is integral to providing quality education in higher education [29]. It shapes student-teachers' interaction with the modules that make up the learning progress and frames their learning [29–31]. This means that remote proctoring tools may create privacy concerns and unintentionally penalize student-teachers with unstable Internet or shared living environments [32]. This is where the issue of inequality arises, with some student-teachers being given more opportunities than others. However, some student-teachers would often not engage in learning tasks unless they are assessed for a clear grade or mark. Thus, assessment now becomes a key driver of

what student-teachers regard as important in their studies, and this shapes their approach to learning [33]. The shift to online learning mainly drives the movement toward continuous assessment with blended and online teaching and learning, which requires different approaches to teaching and learning and assessment [34]. According to [34] online continuous assessment is regarded as a sound assessment strategy that helps reduce the adverse effects of high-stakes, once-off examinations which are promoting rote memorization, cramming, and high levels of anxiety rather than student learning. A comparison of traditional models of teaching and learning and online teaching shows that online teaching and learning require a more sustained engagement between student and materials, student and instructor, and student and institution [34].

2.6. Digital Literacy

A valuable method for assessing literacy across student demographics is the digital skills framework put forth by Beaunoyer et al [14]. This includes operational, formal, information, and strategic Internet abilities. Docrat [35] indicates that language barriers can impede students' understanding and comprehension of instructional material. Furthermore, Hafizhah et al [36] and Docrat [35] agree that language proficiency can pose a significant obstacle to developing digital literacy skills. The prevalence of online resources and learning platforms in English or other colonial languages presents difficulties for students whose first language differs. Language barriers can hinder student-teachers' comprehension and grasp of the instructional material. When content is delivered in an unfamiliar language, they may face difficulties understanding the concepts or instructions. Ng [37] explains that student-teachers are naturally digitally knowledgeable by separating social skills from academic digital skills. Therefore, teaching them how to use digital tools for learning and critical thinking is important. Additionally, Helsper [38] contends that educational institutions must address different levels of digital literacy because access alone does not equate to competency.

2.7. Internet Connectivity

According to a UNESCO report [21], Internet access is still a big problem in sub-Saharan Africa, where student-teachers are frequently forced to rely on expensive mobile data and unreliable networks that limit their capacity to participate in online learning regularly. This results in an urban-rural divide, with student-teachers at rural universities frequently encountering disruptions due to inadequate infrastructure and poor bandwidth [22]. Consequently, inadequate access to technology and the Internet limits student-teachers' access to online educational resources, e-books, research materials, and educational platforms necessary for enhancing learning [39]. It also hinders their ability to learn independently and access up-to-date information when needed [40]. This lack of access creates a significant drawback for student-teachers, especially in remote areas where digital infrastructure is lacking. Due to a lack of Internet connectivity and suitable devices, these teachers are challenged in completing online assignments and performing other activities, such as accessing digital learning materials outside school hours [39,41]. This digital gap influences unequal learning opportunities and hinders their academic progress. Addressing this issue bridges the gap between those with access to resources and those who do not have access, promoting equity in education, closing achievement gaps, as well as preparing student-teachers for success in the digital age.

3. Materials and Methods

The study adopted a qualitative approach with a case study design to explore digital access patterns and institutional strategies within selected universities in Lesotho [42]. This approach allowed for an in-depth understanding of contextual and lived experiences related to digital equity. Two higher education institutions in Lesotho were purposively selected based on access disparities and digital strategy documentation [43]. Twenty student-teachers across different disciplines and years of study were selected to participate through purposive and snowball sampling to ensure

variation in socioeconomic background and geographical location [44]. The sample also included four key informants, including information and communications technology (ICT) officers, student support services, and academic leaders responsible for digital strategy [45]. Data were collected through semi-structured interviews with student-teachers and staff [43]. Focus groups were also conducted with students to explore shared experiences and perceptions. Data were analyzed by employing thematic analysis using Braun and Clarke's [46] six-phase approach, commencing with familiarization of data by reading and re-reading transcripts and then coding the most emerging concepts by assigning codes to them [44]. Themes were generated from these codes to reduce them for reporting. A review was performed on the themes generated to name them. Ethical clearance was sought from relevant institutional review boards, and informed consent, confidentiality, and voluntary participation were also ensured with participants to protect them [47]. Three major themes emerged from the data for this study [48].

4. Results

4.1. Device Ownership and Usage

The study found that many student-teachers rely on smartphones as their primary ODeL learning device, limiting their multitasking and advanced coursework capabilities. While mobile devices allow them to participate in online teaching and learning, they are often limited to access to specific file formats that they have to download, and ease of typing during assessments. Consequently, high data costs are reported, forcing some to limit their online participation and focus only on essential course activities, and avoid optional tasks even when connectivity is available. This concurs with literature [25,27,28] showing that student-teachers from low-income households are less likely to own digital tools or have reliable access, which excludes them from meaningful participation in teaching and learning and impacts their performance. It also reduces their willingness or interest in engaging with technology, as [14] explained in Mezirow's theory. Hence, it becomes a barrier to using digital tools in ODeL environments. Poor or unstable Internet connectivity was the most commonly reported barrier, especially in rural and peri-urban areas, affecting student-teachers' ability to integrate technology effectively in their future classrooms. Due to this consequence, digital inequality widens academic gaps among student-teachers.

On the other hand, those with laptops or tablets expressed greater satisfaction with navigating course materials, participating in discussions, and even completing assignments on time. This finding concurs with Gottschalk and Weise [15] and Pule and Ngoveni. [41], that the lack of Internet connectivity and suitable devices challenges student-teachers in completing online assignments and performing other activities, such as accessing digital learning materials outside school hours. This implies that student-teachers without reliable devices or stable Internet connectivity are placed at a structural disadvantage. It limits their participation in class discussions, affecting their academic performance and sense of belonging within the academic community. This digital exclusion effectively widens the gap between advantaged and disadvantaged student-teachers, undermining the promise of ODeL as a democratizing force in education. Thus, unequal access to devices, Internet connectivity, and digital skills systematically disadvantages certain groups, undermining the principle of equitable learning opportunities. Low socioeconomic status strongly affects the learning experiences of student-teachers from low-income households, who tend to submit their work late, participate less in synchronous activities, and have fewer opportunities for peer collaboration. This lack of access often compounds feelings of isolation and disengagement from the academic community.

4.2. Digital Literacy Disparities

The study found that the differences in digital literacy have also shaped student-teachers' results. Findings show that student-teachers with prior exposure to digital tools adapted quickly to ODeL platforms, while first-time users required extensive support and took longer to achieve

proficiency. Those familiar with digital tools reported adapting more quickly to online platforms than the first-time users, who often need considerable technical support from the university. These are the digital disparities that van Dijk (2020) mentioned in his theory that lead to the digital divide. As highlighted by Docrat [35] and Hafizhah et al [36], a significant obstacle can be posed to the development of digital literacy skills for those who struggle with language when language proficiency is not addressed, as they can easily be demotivated [14]. The absence of adequate digital skills training for student-teachers and their instructors widens the gap between those with prior experience, undermining the promise of ODeL as a democratizing force in education. The study further noted that reliable access to technology correlated strongly with higher grades, greater confidence, and lower stress levels. Conversely, persistent access issues were linked to disengagement, frustration, and higher drop-out risk.

Furthermore, reliable technology access was linked to better academic outcomes. It is evident from Docrat [35] that language barriers can impede student-teachers' understanding and comprehension of instructional material and, therefore, affect their academic performance. It also implies that student-teachers with consistent connectivity and proper devices achieve higher grades because they are exposed to digital tools and can easily use the ODeL platforms to participate and submit their assignments. These students also reported having lower stress levels and greater confidence in their learning than those with unreliable technology. It is evident from [14] that the existing gap can demotivate student-teachers so much that they become unwilling to use digital technologies. Persistent access challenges contribute to increased frustration, reduced motivation, and higher drop-out risk. This implies the absence of adequate digital skills training for both student-teachers and their instructors, which widens the gap between those with prior experience and those without.

4.3. Institutional Strategies to Promote Digital Equity

Some universities can adopt strategies to address digital inequity, from providing loaner devices and data packages to their student-teachers to integrating digital technology into teaching. As outlined by Braun and Clarke [46], some institutions can partner with telecommunications companies to subsidize Internet access for students, while others have developed zero-rated platforms to facilitate free access to academic content. Policy-level interventions, such as digital inclusion frameworks and equity-driven ICT policies, can also be adopted to institutionalize support for disadvantaged students. This is supported by an OECD report [50]. However, the effectiveness of these strategies varies depending on implementation, funding, and student awareness. Several studies have reported gaps between policy intent and student experience, where initiatives are available but underutilized due to poor communication or lack of training [51]. Moreover, digital equity efforts often overlook the importance of socio-cultural and pedagogical factors. These practical strategies require technological solutions and a rethinking of pedagogical practices that must be assumed for uniform digital access and competence, as noted by Maringe and Chiramba [52]. A holistic approach that blends infrastructural support with inclusive teaching practices is essential for meaningful digital inclusion in higher education. Unless preservice teacher education programs adopt holistic strategies, such as zero-rated educational platforms, subsidized data, widespread campus/off-campus Wi-Fi, in-practice technical support, and mandatory digital pedagogical modules, efforts to prepare future teachers for equitable, tech-enhanced schooling will be undermined.

5. Conclusion

In conclusion, the digital divide is characterized by differences in access to technology and digital resources, creating inequalities that hinder learning opportunities. Meanwhile, although improvements in device ownership, digital literacy, and institutional strategies have advanced technology access in ODeL, persistent inequalities remain. Device provision alone does not guarantee effective engagement, as disparities in usage patterns, Internet reliability, and software compatibility

continue to disadvantage certain learners. Similarly, digital literacy interventions often overlook contextual factors, such as language barriers, prior educational exposure, and the hidden costs of participation. Institutional strategies, though increasingly proactive, risk becoming fragmented if they are not informed by comprehensive needs assessments and long-term sustainability plans. Without addressing these structural challenges, technology-driven equity initiatives may inadvertently reinforce existing divides. A truly equitable ODeL environment demands integrated, evidence-based policies that combine access, skills development, and systemic reform, ensuring that technology serves as a bridge rather than a barrier to learning.

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Data Availability Statement: Data are available from the main author and kept safely until the time it is destroyed. For ethical restrictions purposes, data cannot be shared with anyone.

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Abbreviations

The following abbreviations are used in this manuscript:

ODeL	Open Distance e-Learning
ICT	Information and Communications Technology

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