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Assessing the Use of Artificial Intelligence as an Online Learning Technology at the South African Universities of Technology

Skhumbuzo Clement Mtetwa* and Mfanelo Ntsobi

Da Vinci Institute, 16 Park Ave, Modderfontein, Johannesburg, 1609, South Africa

***Corresponding Author:** Skhumbuzo Clement Mtetwa, Da Vinci Institute, 16 Park Ave, Modderfontein, Johannesburg, 1609, South Africa.

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Abstract

Artificial Intelligence has emerged as a transformative tool in higher education, particularly in online learning environments. Despite its growing influence, limited research exists on the specific application of AI in South African Universities of Technology (UoTs). This study aimed to explore the use, benefits, and limitations of AI-driven tools in online learning at UoTs. The study was framed within the constructivist theoretical lens, focusing on how technology can support active learning and student-cantered pedagogy. This research employed a mixed-methods approach, combining both qualitative and quantitative methods to gain a comprehensive understanding of the impact of AI. The study used surveys and interviews as research strategies from a sample of faculty members and students at multiple UoTs. The data collection methods involved were online surveys for students and semi-structured interviews for faculty members. Thematic analysis was used to analyse the qualitative data, while quantitative data were analysed through SPSS version 21.0 (IBM Corporation) for descriptive and inferential analysis.

The findings reveal that AI-driven tools have the potential to significantly enhance student engagement and academic performance, particularly through personalised learning experiences. However, challenges such as infrastructural limitations, insufficient faculty preparation, and ethical concerns, particularly around data privacy, hinder the full integration of AI technologies in UoTs. The recommendations include enhanced faculty training and improving technological infrastructure to support AI implementation.

Keywords: Artificial Intelligence; Higher Education; Online Learning; South Africa; Universities of Technology

Abbreviations

UoTs: Universities of technology.
AI: Artificial intelligence.
IITL: Integration of ICT in Teaching and Learning.
TAM: Technology acceptance model.
UTAUT: Unified Theory of Acceptance and Use of Technology.
TPACK: Technological Pedagogical Content Knowledge.
TRA: Theory of Reasoned Action.
MKT: The Krejcie and Morgan Table.

Introduction & background

Introduction

Recent studies by Ofusori (2021) and Mpungose (2020) assert that the rising adoption of AI in education has transformed traditional learning methods. Franklin and Nahari (2018) cite that AI-powered solutions are rapidly being employed in South African Universities of Technology (UoTs) to help with tailored learning, automate administrative duties, and provide real-time feedback. This study investigated the use of artificial intelligence in online learning, with an emphasis on the influence on students and educators. The study sought to investigate the efficacy, problems, and potential solutions connected with AI-based learning tools in South Africa's higher education sector. This study was underpinned by several key theoretical frameworks that explored technology adoption in the context of online learning in South African UoTs. The primary frameworks included the Integration of ICT in Teaching and Learning and the following theories.1) Technology acceptance model; 2) Unified Theory of Acceptance and Use of Technology; 3) Technological Pedagogical Content Knowledge; 4 Theory of Reasoned Action.

Research objectives

i. To investigate whether the availability of technology or technical support affects the students' willingness to adopt online learning.
ii. To investigate how the lecturers' perceptions of the benefits and drawbacks of online learning affect their attitudes towards it.
iii. To measure the impact of technology adoption reluctancy against learner's performance (assessment scores).
iv. To review the set of best practices to support the adoption of online learning technologies.
v. To make policy and pedagogy recommendations that will support the adoption of online learning technologies.

Research questions

i. How does the availability of technology and/or technical support affect the students' willingness to adopt online learning?
ii. What are the lecturers' perceptions of the benefits and drawbacks of online learning and how does this affect their attitude towards it?
iii. What is the impact of technology adoption reluctancy against learner's performance (assessment scores)?
iv. How should the best practices be reviewed to support the adoption of online learning technologies?
v. How will policy and pedagogical improvements support the adoption of online learning technologies?

Theoretical frameworks

Technology Acceptance Model (TAM)

Developed by Fred Davis in the 1980s, TAM explains how users adopt modern technologies (as cited by Eze et al., 2020). It is particularly relevant for understanding how online learning can be adopted in South Africa, especially for marginalised students in rural areas. This theory focuses on empowering individuals and overcoming social and historical barriers to technology adoption, such as those found in South African UoTs.

Unified Theory of Acceptance and Use of Technology (UTAUT)

Al-Momani and Ramayah (2025) cited that this model extends TAM and identifies four constructs; performance expectancy, effort expectancy, social influence, and facilitating conditions. These constructs influence the implementation and use of online learning in South African UoTs, with a particular focus on how online learning can enhance curriculum delivery, ease of use, and the availability of organisational resources.

Technological Pedagogical Content Knowledge (TPACK)

Tseng et al. (2022) cited that the TPACK framework emphasises the interaction between the instructors' content knowledge, pedagogy, and technology. This framework is critical for understanding how technology can enhance teaching and learning practices in South African UoTs, particularly when adopting online learning.

Theory of Reasoned Action (TRA)

Alshurafat et al. (2021) cited that this theory, developed by Fishbein and Ajzen, explores how attitudes and subjective norms shape behavioural intentions, thus influencing the adoption of online learning technology. It helps explain the role of attitudes in the acceptance of online learning in South African UoTs, focusing on how institutional and user behaviour can impact technology adoption.

Literature review

Conceptualising AI in online learning

Chiu et al. (2022) asserted that Artificial Intelligence in online learning encompasses technologies such as machine learning, natural language processing, and adaptive learning algorithms that enhance the online learning experience by personalising learning paths, predicting student success, and providing real-time support. These AI tools assess students' learning styles, identify potential challenges, and adapt content to suit individual progress, thereby making learning more dynamic and tailored to each student's needs.

Online learning, supported by technological advancements, provides flexibility and accessibility, enabling students to learn at their own pace from anywhere (Eze et al., 2020). Studies, including those by Mohammed et al. (2021) and Khalid et al. (2020) highlighted that AI integration in online learning can significantly improve academic performance by offering personalised content and real-time feedback, especially for students who may struggle in traditional learning environments.

AI's ability to predict success and identify areas of difficulty allows for targeted interventions, which enhances student engagement and achievement, as noted by Marongwe et al. (2019). However, Yaseen, Alsoud, Nofal, Abdeljaber and Al-Adwan (2021) point out that reluctance towards AI adoption, particularly due to inadequate technological infrastructure, can limit its effectiveness. Despite these challenges, AI continues to show great potential in transforming online learning, offering greater personalisation and efficiency, provided that proper infrastructure and support are in place.

AI adoption in higher education

AI-powered platforms, such as virtual tutors, automated grading systems, and intelligent chatbots, have gained global popularity in higher education. However, in South Africa, the use of AI in higher education is still in its early stages, with universities gradually integrating AI-driven learning management systems (Khalid et al., 2020). Online learning offers benefits such as flexibility and convenience, but its effect on academic performance is widely debated.

According to Mohammed at al. (2021), AI enables students to learn at their own pace, which can potentially enhance academic performance by providing personalised learning experiences. Yaseen et al. (2021) argue that the absence of in-person interaction between students and instructors in online learning environments could negatively impact academic performance.

These differing perspectives highlight the ongoing debate about AI's role in enhancing or hindering academic outcomes in higher education. Moreover, effective technology adoption leads to better engagement and higher performance, so reluctance to adopt technology can hinder students' academic growth (Khalid et al., 2020, Marongwe et al., 2019).

Benefits of AI in online learning

Personalised learning

AI-powered personalised learning has transformed student engagement by adapting to individual learning needs and methods, making education more tailored and accessible. Additionally, Eze et al. (2020) emphasise that AI technologies adjust learning paths based on student progress and preferences, providing a more individualised experience. This flexibility is particularly beneficial in online learning, where students can study at their own pace, which is essential for those balancing work or family commitments.

As Krasodomska and Godawska (2021) notes, AI enables global access to educational resources, removing geographical and time barriers, and empowers students to pursue their academic goals more effectively. Furthermore, AI-driven personalised learning improves academic performance by allowing students to engage with content that suits their unique pace and progress, as highlighted by Mohammed et al. (2021).

Efficiency

AI automates grading and administrative work, allowing educators to focus on teaching. As a result, it has altered the way education is approached and it is expected to offer significant advantages over physical learning. Khalid et al. (2020) note that AI's ability to streamline administrative processes allows educators to allocate more time for direct interaction with students, enhancing the overall educational experience.

Improved accessibility

Eze et al. (2022) cite that AI tools, particularly voice-to-text and text-to-speech applications, have significantly enhanced accessibility for students with impairments, helping to eliminate learning barriers. Additionally, the rise of online learning, driven by digital platforms, has provided students with the flexibility to learn remotely. These AI technologies not only improve the learning experience for students with disabilities but also make online education more inclusive and adaptable for diverse needs.

Enhanced engagement

Mohammed et al. (2021) assert that AI-powered gamification and interactive learning modules enhance student motivation by making learning more engaging and enjoyable. AI integration in online learning environments boosts student engagement through personalised feedback and experiences that promote active participation. Furthermore, online learning adoption, supported by AI, helps democratise education by providing access for a broader range of students, including those facing geographical, financial, or social barriers, thereby improving academic outcomes and fostering inclusivity.

Challenges of AI adoption in South African UoTs

The limitations of AI implementation in higher education institutions, notably in poor nations, are numerous. A study by Yaseen et al. (2021) also highlights that a significant barrier to AI adoption in countries like South Africa is the lack of technological infrastructure and digital literacy, which hinders the full potential of AI tools in educational settings. A study by Moyo (2019) finds that stakeholder engagement is critical to the success of online learning adoption in South African universities, and Mpungose (2020) also notes that technical and financial support from the government is essential for successful technology adoption.

Infrastructure constraints

The effective adoption of online learning has been hampered by students' inability to access resources due to inadequate ICT infrastructure. Additionally, Marongwe (2019) argues that financial constraints and the excessive cost of implementing AI technologies are major obstacles, as many institutions struggle to fund the necessary infrastructure and training for both educators and students.

Faculty readiness

A lack of technical knowledge causes resistance to AI integration. Many lecturers in the industrialised world struggle to incorporate technology into their teaching methods since they are unfamiliar with online learning platforms. Furthermore, Sarker et al. (2019) point out that inadequate internet connectivity, especially in rural areas, poses a major challenge to the widespread adoption of AI-powered learning systems for students of South African UoTs.

Data privacy concerns

There are ethical ramifications to the AI monitoring of student data although online learning was first viewed with suspicion, the Covid epidemic brought attention to the necessity of implementing flexible and adaptive learning environments, which accelerated the universities' embrace of online learning. Sarker et al. (2019) affirms the problematic integration of AI in online learning environments, and it requires the secure handling of sensitive student information to prevent data misuse or unauthorised access.

High implementation costs

Yaseen et al. (2021) note the financial limitations to the purchase and upkeep of AI systems. The implementation of online learning has been significantly hampered by a lack of funding. Additionally, the expense of education has been a major obstacle in many developing nations, to the point that most UoTs in these nations have been unable to implement online learning due to the enormous financial requirements. The reluctance to embrace AI tools also stems from a resistance to change, with Yaseen et al. (2021) noting that educators and students in some cases may be reluctant to adopt innovative technologies due to unfamiliarity or concerns about the impact of AI on traditional teaching methods.

Research methodology

A mixed-methods approach was employed to gather data from faculty members, students, and administrative staff across selected UoTs. The three main stages of the inductive research approach are observation, recognition of data patterns and theory development (Casula et al., 2021).

This study employed the abduction research approach because it consists of observing existing evidence and the empirical phenomena before developing the best conclusions (Hurley, Dietrich and Rundle-Thiele, 2021). The abduction research approach overcomes the weaknesses by adopting the mixed-methods (pragmatist) perspective of starting with the facts before moving between deduction and induction approaches to obtain the most probable explanation (Proudfoot, 2023). In this study, the abductive research approach addressed the weaknesses of the inductive and deductive approaches; the lack of needed clarity. The abduction research approach involved analysing a list of unfinished observations about challenges to technology adoption to generate the best estimate or explanation of the opportunities for technology adoption.

Research design

Because this study collected and analysed both quantitative and qualitative data, it used a mixed-methods research design. If neither the qualitative nor the quantitative data can adequately address the study issue on their own, the mixed methods research design is the best option. The study's generalisability, contextualisation, and credibility are provided by the mixed method design. This study adopted the mixed-methods research design because it involved gathering and analysing both quantitative and qualitative information. Baran (2022) stated that the mixed-methods research design is ideal if neither the qualitative data nor the quantitative data can alone offer sufficient answers to the research question.

The mixed-methods design offers the study generalisability, contextualisation, and credibility (Dawadi, Shrestha and Giri, 2021). In this study, using the different data collection methods on a single subject (triangulation) gave more credit and convergence to the study results. This study adopted the mixed-methods research design to collect and generalise huge volumes (quantitative) of in-depth infor-

mation (qualitative) on the opportunities and challenges to successful online learning in South Africa's higher education institutions.

The researcher used a concurrent triangulation method, which means that data from qualitative and quantitative methods were gathered at one phase and concurrently. This assisted the researcher to examine the data to find differences, convergences, and combinations. The main aim of this method was not only to cover the demerits of one of the single methods but to also strengthen the other one and to add the strengths of both methods.

A mixed-methods design offers a number of benefits to approaching complex research issues as it integrates the philosophical frameworks of both post-positivism and interpretivism, interweaving qualitative and quantitative data in such a way that research issues are meaningfully explained. It also offers a logical ground, methodological flexibility, and an in-depth understanding of smaller cases (Maxwell, 2023). Taherdoost (2022) states that the use of mixed-methods enables researchers to answer research questions with sufficient depth and breadth and helps generalise findings and implications of the researched issues to the entire population. For example, the quantitative approach helps a researcher to collect data from a large number of respondents, thus increasing the possibility of generalising the findings to a wider population.

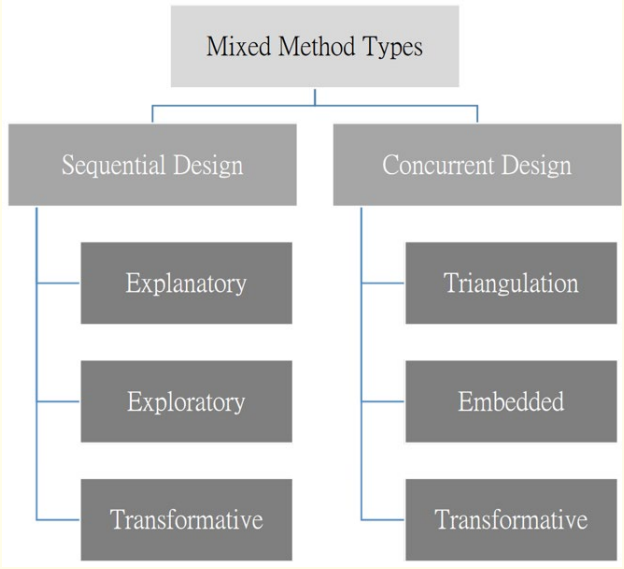

Figure 1: Illustrates the sequential design method and concurrently design method.

Quantitative component

A quantitative study design collects and analyses numerical or quantifiable data. Surveys were given to students and faculty members to evaluate AI usage and the questions should be interesting to the participants and not be too long, invasive, and/or complicated.

Qualitative component

This involved extensive interviews with administrators and educational technologists. The qualitative study design delves deeply into how people interpret their environment and the meanings that influence their behaviour. The selection criteria for the researcher included asking the research office for a list of lecturers and their email addresses, getting permission from the research ethical officer to send emails to all lecturers asking them to participate in the study, and deciding with the lecturers who responded with a suitable time and date for the interviews, which were conducted successfully.

Sample selection

Universities that have used AI-based online learning resources were the focus of a purposive sampling technique. The researcher recruited 400 students from six South African UoTs to get both quantitative and qualitative data, and 18 instructors, 12 curriculum creators, and 10 policy developers to gather qualitative data. According to the Krejcie and Morgan Table (KMT) (1970) criteria, the sample size consisted of 440 participants; 400 students, 18 lecturers, 12 curriculum creators, and 10 policy developers.

The Krejcie and Morgan Table (KMT) (1970) is widely used in behavioural and social science research to determine sample size; it does not require any calculations and can be applied to any defined population. According to the KMT, a sample size of 384 is adequate for a population of one million or more, and as a result, 384 was considered the magic number in research and has been used in hundreds of articles and theses to date.

Data collection and analysis

Data were collected through structured questionnaires and semi-structured interviews. Thematic analysis was employed for the qualitative data, while statistical methods were used for the quantitative insights. Structured questionnaires contain pre-defined questions, specific schemes, exact wording, and order of questions.

The study employed thematic analysis for the qualitative data analysis because it aids in identifying the patterns and meanings which emerge in the data sets. For the quantitative data analysis, this study used SPSS version 21.0 (IBM Corporation) for descriptive and inferential analyses. Descriptive statistics helped in summarising the quantitative data, while inferential statistics helped compare and generalise the findings to the larger total population.

Findings and discussion

AI Usage in South African UoTs

The survey results indicated that AI-driven chatbots, plagiarism detection tools, and predictive analytics were the most commonly used AI applications in online learning. However, the adoption levels varied across institutions based on infrastructure readiness. A strong IT foundation is essential to online learning's success. The newest educational technology is incompatible with many institutions' antiquated systems.

Participant 9 brought attention to online learning adoption problems by stating them as follows:

Technology infrastructure, student motivation, technological difficulty awareness, and attitude towards ICT.

According to the participants, it is essential to guarantee strong IT support and frequent updates. The ICT infrastructure was found to be the most difficult component as the ongoing comparison of the gathered data and data analysis advanced. According to the research data, the institutions confront a number of infrastructure-related difficulties, including problems with network connectivity, especially in rural locations where several UoTs are located.

Participant 5 indicated stated:

Inadequate IT infrastructure within the institution, leading to slow internet speeds, server downtimes, or other technical issues.

The lack of proper ICT infrastructure has made it difficult for students to access online learning resources, thereby hindering the effective adoption of online learning.

Student perceptions of AI in learning

Although there were concerns about data security and bias in AI-generated learning, recommendations were brought to light, and students generally viewed AI tools as helpful for academic support and personalised learning. One of the biggest benefits of online

learning is the scheduling flexibility it provides, which is essential for accommodating non-traditional students, such as those who have family or work obligations.

Null Hypothesis: H_0 There is no positive relationship between the availability of online technology and students' willingness to adopt online learning.

Alternative Hypothesis: H_a There is a positive relationship between the availability of online technology and students' willingness to adopt online learning.

A Pearson correlation test was performed to test this hypothesis, and the findings are presented in Table 1 below.

		Availability of online technology	***Student willingness to adopt online learning***
Availability of online technology	Pearson Correlation	1	.813**
	Sig. (2-tailed)		.000
	N	400	400
Students' willingness to adopt online learning	Pearson Correlation	.813**	1
	Sig. (2-tailed)	.000	
	N	400	400

Table 1: Pearson correlation test results on hypothesis one.

The findings revealed a significant positive correlation between the availability of online technology and the students' willingness to adopt online learning, with a Pearson correlation coefficient of .81. The p-value of .000, significant at a 2-tailed level, indicated strong evidence to reject the null hypothesis. These results provide robust evidence to support the alternative hypothesis, suggesting that there is indeed a positive relationship between the availability of online technology and student willingness to adopt online learning. It implies that when online technology is easily accessible, students are more likely to embrace and adopt online learning methods.

As a result, institutions and educators should consider providing adequate access to online technology to increase the students' willingness to engage in online learning, ultimately leading to more effective and successful education experiences.

P9 (Participant) revealed that:

Online learning offers flexibility in learning schedules, which is beneficial for students who work part-time or have other commitments.

It has been demonstrated that flexible scheduling boosts student happiness and enrolment. Some participants stated that online learning provides flexibility, convenience, and low costs that traditional education cannot match, as was previously covered in the literature study.

In support of this statement, P10 expressed that:

Enhanced flexibility in scheduling can help to accommodate part-time students.

This was also supported by P4 who avowed that it:

Allows the institution to manage and deliver educational content efficiently.

One of the biggest advantages of online learning is its flexibility as students can learn at their own pace and on their own schedule, which allows them to balance their studies with work or other commitments. This is evident as supported by P9 who said:

An ability to easily organise Saturday classes.

The following statements were made by participants in support of the aforementioned statement by P9:

P12 expressed that it:

Minimises time to travel, being able to attend class in your comfort zone anywhere. Not having to relocate to be closer to school.

The study's findings support those of the authors of Venkatesh, Morris, Davis and Davis (2003) and Yaseen et al. (2021) who find that the flexibility and adaptability of learning environments are among the main advantages of implementing online learning. Additionally, it is determined that the use of online learning has a substantial impact on distant education by enabling students to pursue their academic objectives and access educational materials from any location in the world (Krasodomska and Godawska, 2021).

Faculty attitudes towards AI integration

Although faculty members saw the potential of AI, they voiced worries about changes in their workload, the need for training, and ethical issues with assessments powered by AI. Support from management is crucial for the adoption and integration of new technologies. Without commitment at the higher levels of administration, initiatives can falter.

P28 noted:

Lack of management support in endorsing online learning and financial support for online education technologies.

It appears that lack of management support is another challenge that affects the technology adoption of online learning at the UoTs. The literature on change management in education emphasises the importance of leadership in driving technology adoption.

P14 asserted that:

Lack of management support in endorsing online learning and financial support for online education technologies.

According to some participants, inadequate training and support can cause instructors and students to become frustrated, which lowers the efficacy and effectiveness of online learning, and eventually results in the poor adoption of online technology.

Online learning technology used

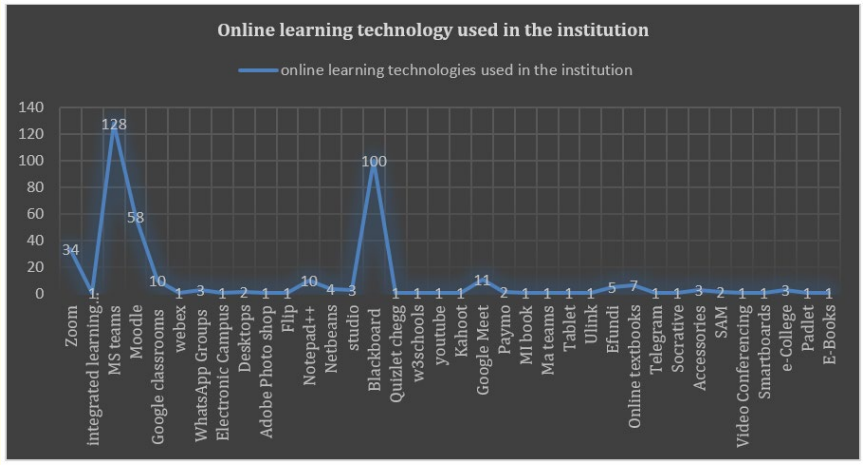

Figure 2

According to Figure 2, Microsoft Teams (128 respondents) was the most used online learning technology at the institution, followed by Blackboard (one hundred respondents). The other commonly employed online learning technology platforms were Google Classroom (58 respondents), Zoom (34 respondents) and Flip (one responded). From the above, this study found that the institutions used a range of online learning technology platforms for learner education.

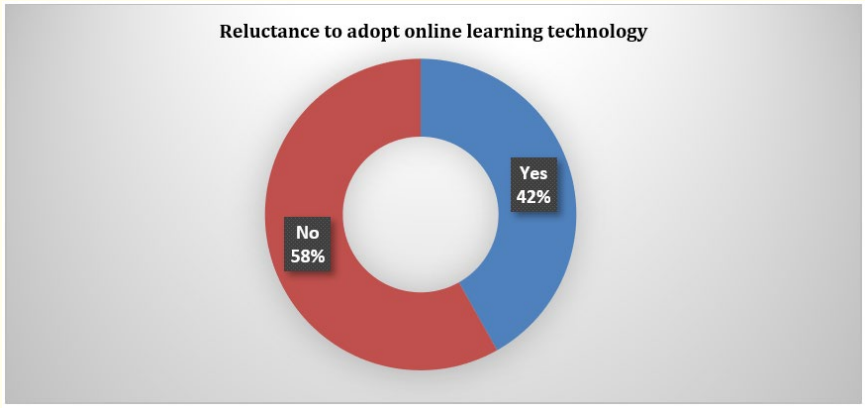

Figure 3

Figure 3 indicates that the majority (58%) of the respondents did not have any reluctance to adopt online learning technology at their institution. Only 42% were reluctant to adopt online learning technology. The study results above established that learners were willing to adopt online learning technology at their institutions.

Challenges hindering AI adoption

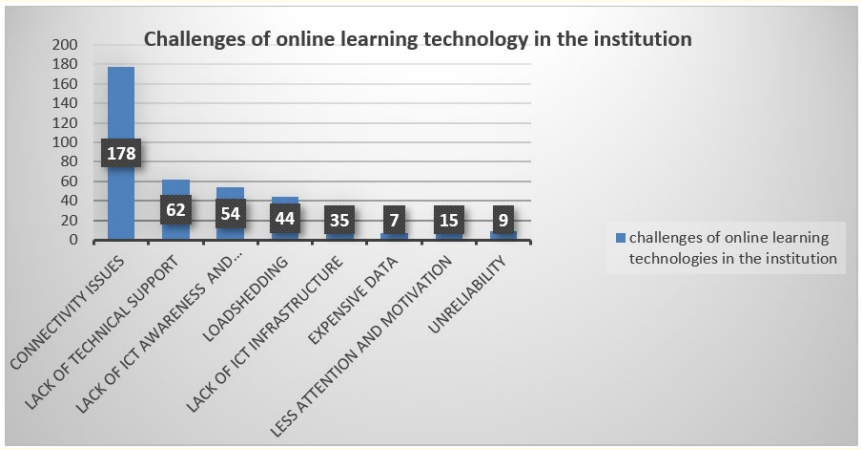

Figure 4

According to Figure 4, the leading challenge (44%) to online learning technology was connectivity (Wi-Fi, computer and network) issues. The respondents also lacked the needed technical support (15%) for online learning. The other key challenges to online learning in the institution were regular loadshedding (11%), the lack of ICT infrastructure (9%), less attention and motivation (4%), unreliability (2%) and expensive data costs (2%). This study established that learners at South African universities of technology face various challenges in adopting the institution's online learning technology platforms.

Limited digital infrastructure

High data prices and unequal access to AI-enabled gadgets were common challenges. A strong IT foundation is essential to online learning success. Many educational institutions have challenges due to antiquated systems that are unable to accommodate the newest technologies.

P9 highlighted the issue of adopting online learning by noting the following:

Technology infrastructure, student motivation, technological difficulty awareness and attitude towards ICT.

According to the participants, it is essential to guarantee strong IT support and frequent updates. The ICT infrastructure was found to be the most difficult component as the ongoing comparison of the gathered data and the data analysis advanced. According to the research data, the institutions confronted a number of infrastructure-related difficulties, including problems with network connectivity, especially in rural locations where several UoTs are located.

P5 indicated that:

Inadequate IT infrastructure within the institution, leading to slow internet speeds, server downtimes, or other technical issues.

The lack of proper ICT infrastructure has made it difficult for students to access online learning resources, thereby hindering the effective adoption of online learning.

Lack of policy frameworks

The absence of clear guidelines on AI implementation in higher education is problematic. A fundamental challenge in the adoption of online learning technologies is the lack of awareness among educators and students about the potential benefits and uses of these tools.

P8 noted:

Lack of familiarity with online learning platforms, tools, and resources.

Such lack of awareness is likely to result in non-implementation of existing technology, and resistance to abandon previous processes or systems. Society requires special educational campaigns that would involve people and demonstrates the advantages of using online learning media.

Training gaps

There is a need for faculty development programs in AI usage. Online technologies also offer vast resources for faculty development.

P8 proclaimed that:

Online platforms offer opportunities for educators to engage in continuous professional development. This includes workshops, webinars, and online courses to enhance teaching skills, keep up with advancements in their field, and learn new instructional technologies.

As noted by one participant, continuous professional development is essential for educators to keep updated with the latest teaching strategies and technologies. In support of this statement, P7 also avowed that:

> *Lecturers engage in online professional development courses to enhance their lecturing skills and stay updated on the latest educational technologies.*

Conclusion and recommendations

AI presents significant opportunities for enhancing online learning in South African UoTs. However, effective integration requires addressing infrastructural, policy, and training challenges. The study has the following recommendations:

Investment in digital infrastructure to support AI-driven learning

Thanks to better ICT infrastructure, instructors and students can more readily access e-learning materials and finally adopt online learning. The enhanced ICT infrastructure at South Africa's higher education institutions, notably rural UoTs, is helping to bridge the present digital divide between students in rural and urban locations. Regardless of geographic distance, both students and faculty members will have access to comparable online learning resources. The use and uptake of e-learning among South African institutions can be improved with the consistent use of ICT infrastructure, such as PCs.

Development of institutional policies for AI ethics and data privacy

Even though online learning platforms are not changing the role of universities, they are changing how universities deliver learning and teaching. There is a gap in applying the right pedagogy. Blended learning requires the lecturer to guarantee the incorporation of technology into the learning and teaching environment. UoTs need to devise strategies for maintaining academic integrity in e-learning assessments, such as the use of secured proctoring services, creating creative course assessments, and promoting integrity and honesty.

To prevent any lag in the student adoption of the technologies, governments must prioritise the effective implementation of online learning in addition to educational policies that express a preference for it. South Africa must address economic challenges at the national level, as well as issues of cultural inclusivity and student and staff representation in institutional decision-making.

Capacity-building programs for faculty and students on AI literacy

Better training for lecturers and students on the meaningful and efficient use of ICT devices is the other conclusion on best practice. Regular inductions and workshops are ideal for educating lecturers and students about the institution's online learning. The provision of adequate support and training to students, instructors, and other staff members also increases the effectiveness and efficacy of online learning, which in turn increases the adoption of online technology. Institutions must provide educators and students with appropriate e-learning training to ensure the increased use of the online learning platforms.

Government and private sector collaboration to fund AI-based educational technologies

Increasing the amount of financial and technical assistance provided by university administrations, local government, and the national government, is another best practice to encourage the adoption of online learning technology. Better financial investment or commitment, as well as technological expertise, are essential components for the expanded use of online learning among UoTs since they minimise the expense of implementing online education. The availability of funding, infrastructure, resources, and equipment required to create and maintain online learning platforms sustainably must be guaranteed by the UoTs. Providing both fiscal and technical support represents a remarkable strategy to promote the adoption of online learning technology. Future research should explore AI's long-term impact on student outcomes and the feasibility of fully AI-driven educational models in South Africa.

Conclusion

The study highlighted the benefits of AI in creating an inclusive and flexible learning environment. However, it underscored the critical barriers to its widespread adoption. While AI can enhance learning outcomes, its effective implementation requires addressing the infrastructural and pedagogical challenges identified in the study. Therefore, the study concluded that AI has the potential to transform online learning in South African UoTs but requires significant investment in infrastructure and faculty development. The limitations of the study included its focus on a limited number of universities, and future research should explore the long-term impact of AI on student outcomes. There is still much work to be done in carrying forward what I believe to be much needed reforms and the introduction of artificial intelligence tools as an online technology at the universities of technology. Especially, it is worthy of further research that how the matter of interactions would impact learning behaviour and academic achievements of online learning learners and how could we apply it to guide our teaching system design and learning materials' development.

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