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# AI Adoption in Southern African Open and Distance e-Learning: A Systematic Review

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**Abstract.** The integration of Artificial Intelligence (AI) into Open and Distance e-Learning (ODeL) systems is now a very important aspect in higher and tertiary education worldwide and this also includes Southern Africa. This paper reviewed a total number of 79 peer reviewed studies and other relevant publications from the year 2019 to 2025, examining how AI was being employed to improve teaching, research, learning, and administration processes in ODeL institutions in the Southern Africa region. This research study explored how AI was used address challenges that are peculiar to the Southern African region by looking on aspects to do with high student to instructor ratio, resource constraints, lack of proper expertise, and limited digital infrastructure. Findings from the research study reveal that although AI can offer solutions such as Personalised learning, automation of administrative processes, enhanced learner engagement, and automated assessments, its implementation in most ODeL institutions is hindered by lack of proper infrastructure, lack of expertise, and policy gaps. The review highlighted the need for regional collaboration among Higher Education ODeL institutions, investment in ICT infrastructure, and comprehensive policy development for successful implementation of AI. Findings obtained can assist major stakeholders that include Higher education leaders, policymakers, researchers and students on the potential of AI to transform Open and Distance electronic Learning in Southern Africa.

**Keywords**: Artificial Intelligence, Southern Africa, Open and Distance, Electronic Learning

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## 1. INTRODUCTION

The introduction Open and Distance e-Learning (ODeL) has become the foundation for many higher and tertiary institutions in Southern Africa, providing many students with flexible and accessible learning opportunities irrespective of geographical location [1]. ODeL has become a popular educational model globally due to its flexibility and inclusiveness especially during the COVID-19 pandemic [2]. Many higher and tertiary institutions shifted to online learning during the COVID-19 period thereby exposing critical gaps in preparedness to provide equitable and effective e-learning experiences [3].

In the context of Southern Africa, many ODeL institutions face challenges such as limited resources, high student to instructor ratios, and infrastructural constraints ([4]. Furthermore, high student to instructor ratio, lack of proper digital tools as well as huge differences in technological infrastructure between urban and rural areas are other challenges faced in ODeL institutions [4], [5]. These challenges affect ODeL institutions' efforts of providing inclusive and enhanced education across urban and rural settings.
World over, Artificial Intelligence (AI) is rapidly transforming many sectors including education through innovative personalized effective solutions to teaching and learning challenges [1], [6].

AI technologies have the potential to transform how educational content can be delivered, accessed, and experienced in ODeL environments [7]. AI can assist in the automation of administration processes, enhance personalized learning experiences, and assist educators in their instructional roles hence enhance accessibility, inclusivity and quality of education in ODeL settings. Furthermore, AI technologies such as intelligent tutoring systems, recommender systems, and natural language processing can further assist in bridging gapes by offering personalized, scalable and resource efficient solutions in ODeL [1], [7], [4]. The commitment of established organizations such as Microsoft to train one million South Africans on AI and Cybersecurity by 2026 shows that these technologies have a great transformative force in education and workforce development [3].

However, integrating AI into ODeL systems in Southern Africa comes with its own challenges. Literature points out that there are still concerns in aspects such as data privacy, infrastructure development, reduction of human interaction in learning and algorithmic bias [4], [8]. There is a need for ODeL institutions to come up with robust policies and frameworks that ensure ethical and inclusive use of AI technologies in education. It is very important for ODeL institutions to address such challenges so that the full potential of AI can be unlocked hence transform ODeL into Southern Africa [4], [9], [5].

This research paper seeks to explore the adoption of AI in ODeL within Southern African higher education. The study aims to examine the use of AI in ODeL institutions across Southern Africa and identify the success and challenges faced. Lastly the study seeks to provide insights on how AI can best be implemented to enhance teaching and learning in ODeL environments. Section 2 presents the problem statement while section 3 presents the methodology employed for the systematic review. Furthermore, section 4 provides the results gathered from reviewed literature and highlights coding ideas that can be implemented based on the literature reviewed. Section 5 highlights the discussion of the research study while section 6 provides the conclusions.

## 2. METHODS

The aim of the study is to examine the application of AI in ODeL institutions in Southern Africa, focusing on potential benefits and challenges faced. Systematic review methodology was adopted to evaluate opportunities, challenges and trends associated with the adoption of AI in ODeL institutions in the Southern African institutions. The focus was on countries such as South Africa, Zimbabwe, Botswana, Zambia and Malawi. This study selected literature using a three-level approach.

To ensure selection of relevant articles, the study first evaluated keywords, titles and abstracts of articles. Secondly, a thorough analysis of the titles was done to select only the articles that aligned with the scope of the research. Lastly, the study also evaluated the credibility of articles selected by thoroughly going through their abstracts to ensure they were in line with the objectives of the study.

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A thorough search was done in academic and open-access databases that include Google Scholar, ResearchGate, the Directory of Open Access Journals (DOAJ), Institutional repositories, ScienceDirect and Semantic Scholar. The secondary sources were extracted using key words "Artificial Intelligence" AND "Open and Distance Learning," "AI in ODeL" AND "Southern Africa," "AI adoption" OR "AI implementation" AND "Zimbabwe" OR "Zambia" OR "Malawi," and "AI challenges" AND "eLearning" AND "Southern Africa". The review targeted literature that was published between 2019 to 2025 to gain more insights on the recent use and adoption of AI in ODeL institutions in the Southern Africa Region.

Thematic analysis was employed to identify, categories, analyse and interpret key insights from secondary data collected to ensure a thorough understanding of AI adoption in ODeL institutions, focusing on the potential benefits and challenges being faced. The study started with an initial pool of 143 studies and the inclusion and exclusion criteria were used. The study selected studies that mainly focused on the application of AI in ODeL institutions mainly within the Southern Africa region and were peer reviewed or reports from institutions. All the literature selected was published in English. The study remained with 79 studies after a thorough screening process.

### 2.1. Data Inclusion and Exclusion Strategy

Table 1 shows the inclusion and exclusion criteria that was utilised in this study. The criteria assisted in coming up with a sample of articles that were very relevant to the objectives of the study. This was done to select high quality articles that give insight into AI Adoption in Southern African Open and Distance e-Learning.

**Table 1.** Inclusion and Exclusion Criteria

| Aspect | Inclusion Criteria | Exclusion Criteria |
|---|---|---|
| Subject | Articles that have the key words of the research study | Articles that focused on other unrelated areas (Agriculture, Health, Mining, etc.) |
| Document Type | Peer-reviewed journal articles, Institutional repositories | Short Survey, Book Chapter, editorial |

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| Aspect | Inclusion Criteria | Exclusion Criteria |
|---|---|---|
| Selection Criteria | Articles that gave access to the whole article | Articles that provide titles and abstracts |
| Year of publication | Articles from 2019-2025 | Papers older than 2018 |
| Language | English | Other Languages |

### 2.2. Systematic Literature Review

The study selected the relevant literature from Google scholar, ResearchGate, the Directory of Open Access Journals (DOAJ), Institutional Repositories, ScienceDirect and Semantic Scholar as outlined in the Systematic Literature Review flowchart below. On the first phase of the process, about 453 were retrieved. The second phase selected articles that were peer reviewed to ensure quality of the research study. From 453 in Phase 1, the total number was narrowed down to 246 in the second phase where relevant journal articles and institutional repositories were prioritized. The third phase further removed articles that were irrelevant, duplicates and non-English. The final fourth phase resulted in the selection of 79 total articles to assist in answering the research question of the study as shown in Table 2 and Figure 1.

**Table 2.** Inclusion and Exclusion Criteria

| Database | Search String | Hits |
|---|---|---|
| Google Scholar | "Artificial Intelligence" AND "Open and Distance Learning," "AI in ODeL" AND "Southern Africa," "AI adoption" OR "AI implementation "AND "Zimbabwe" OR "Zambia" OR "Malawi," and "AI challenges" AND "eLearning" AND "Southern Africa" | 109 |
| Directory of Open Access Journals (DOAJ) | "Artificial Intelligence" AND "Open and Distance Learning," "AI in ODeL" AND "Southern Africa," "AI adoption" OR "AI implementation" AND "Zimbabwe" OR "Zambia" OR "Malawi," and "AI challenges" AND "eLearning" AND "Southern Africa" | 59 |
| ResearchGate | "Artificial Intelligence" AND "Open and Distance Learning," "AI in ODeL" AND "Southern Africa," "AI adoption" OR "AI implementation" AND "Zimbabwe" OR "Zambia" OR "Malawi," and "AI challenges" AND "eLearning" AND "Southern Africa" | 81 |

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| Database | Search String | Hits |
|---|---|---|
| Directory of Open Access Journals (DOAJ) | "Artificial Intelligence" AND "Open and Distance Learning," "AI in ODeL" AND "Southern Africa," "AI adoption" OR "AI implementation" AND "Zimbabwe" OR "Zambia" OR "Malawi," and "AI challenges" AND "eLearning" AND "Southern Africa" | 57 |
| ScienceDirect | "Artificial Intelligence" AND "Open and Distance Learning," "AI in ODeL" AND "Southern Africa," "AI adoption" OR "AI implementation" AND "Zimbabwe" OR "Zambia" OR "Malawi," and "AI challenges" AND "eLearning" AND "Southern Africa" | 73 |
| Semantic Scholar | "Artificial Intelligence" AND "Open and Distance Learning," "AI in ODeL" AND "Southern Africa," "AI adoption" OR "AI implementation" AND "Zimbabwe" OR "Zambia" OR "Malawi," and "AI challenges" AND "eLearning" AND "Southern Africa" | 74 |
| **Total** | | **453** |

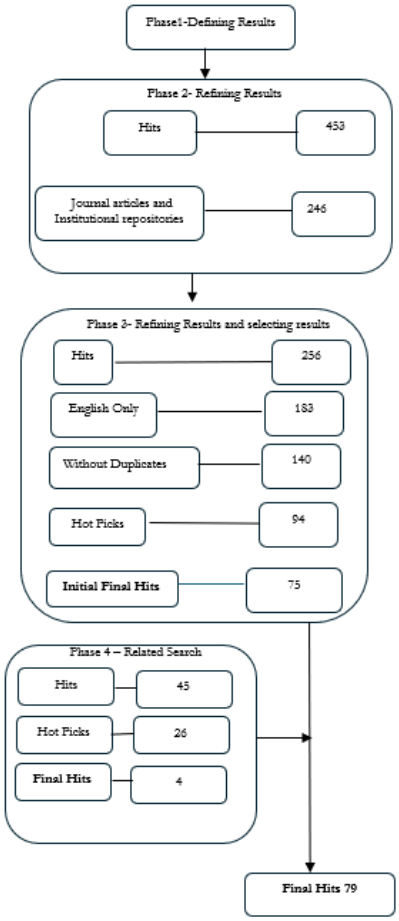


**Figure 1.** Definition of Final Results.

## 3. RESULTS AND DISCUSSION

### 3.1. Overview of Open and Distance e-Learning (ODeL)

Open and Distance e-Learning (ODeL) is defined as an educational approach that utilises open learning principles, e-learning technologies and distance education methodologies to help students with flexible, affordable and accessible learning opportunities. According to [10] ODeL is an educational approach that utilizes open and distance learning models that remove all barriers to learning access and allow learners to study remotely with the aid of digital platforms and virtual classrooms ([11], [2]. Under the ODeL model of learning, students will be able to manage their own pace and place of study utilizing electronic resources for instruction, engagement and assessment. In recent years, several ODeL instruments have integrated digital platforms such as Learning Management Systems (LMS) to facilitate synchronous and asynchronous learning. Institutions such as the University of South Africa (UNISA) and the Zimbabwe Open University (ZOU) have implemented e-tutoring systems that allow students to engage with learning materials and participate in online discussions and assessments [12].

However, ODeL models face several challenges that include the need for a robust infrastructure, lack of students' participation and engagement. Despite the challenges, ODeL institutions are adopting technology such as Artificial Intelligence (AI) in their systems to meet the diverse needs of their students [13], [14]. The application of Artificial Intelligence (AI) in ODeL can help in enhancing student learning experiences and solving key challenges in remote learning. AI is defined as a branch of computer science that is focused on the creation of computer systems that mimic and perform tasks that require human intelligence [15]. The systems can perform tasks such as learning, problem solving, reasoning, and language processing.

### 3.2. Overview of Artificial Intelligence (AI) in ODeL

Artificial Intelligence (AI) is defined as a branch of computer science that is focused on the creation of computer systems that mimic and perform tasks that require human intelligence [16]. AI can perform tasks that include reasoning, learning, problem-solving, understanding natural language, and perception [17].

### 3.2.1. Branches of Artificial Intelligence (AI) in ODeL

AI can be categorised into different branches that focus on various aspects of intelligent behavior. One branch of AI is Machine Learning (ML), which mainly focuses on enabling computers to learn from data that is available and continually improve with time without explicitly being programmed. Another branch of AI is Natural Language Processing (NLP), which focuses on the interaction of computers and human languages [18]. With NLP machines are capable of understanding, interpreting, and generating human language [19]. On the other hand, Computer Vision is another branch of AI that focuses on allowing machines to interpret and process visual information from the world just like human vision. Robotics is another branch of AI that combines AI with mechanical engineering to enable the design and operation of robots to perform tasks autonomously [18]. Another very important branch of AI is Expert Systems.

Expert systems focus on emulating the decision-making capabilities of a human expert using a knowledge base and a set of rules [20]. Lastly, Deep Learning is another subfield of machine learning that makes use of neural networks and is particularly used in performing tasks such as image and speech recognition. The above-mentioned branches of AI allow it to be fused in different domains such as education, health, finance and transportation among others.

### 3.2.2. Importance of Artificial Intelligence (AI) in ODeL

AI is increasingly becoming a very important in Open and Distance e-Learning (ODeL) institutions in Southern African. AI is providing innovative solutions to some of the challenges that are peculiar to most Southern African ODeL institutions [21]. Solutions are being provided in long-standing challenges experienced in the access, delivery, and provision of quality of education. In their research study [22] stated that AI is being adopted in Southern African Universities and has potential to enhance teaching and learning through Intelligent Tutoring Systems (ITS) which can provide personalised learning, instant feedback, and offering educational content according to student needs [23], [24]. AI powered adaptive learning platforms can analyse student data such as performance data and customise learning content based on student knowledge level and learning needs.

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AI can also be utilised to automate assignment assessments thus allowing faster grading and provision of instant feedback. This will enable instructors to consistently evaluate student work and in the end lesson workload [25]. Another very critical component that AI can provide is learner analytics. This component assists instructors and administrators to identify at-risk students by tracking their engagement, performance patterns hence provide timely interventions that could assist in retention rates. Despite all the benefits posed by AI, most Southern African ODeL institutions often face peculiar challenges such as limited technological infrastructure, a shortage of skilled professionals with expertise in AI technologies and issues to do with ethics and data privacy [26]. Several literatures point out that there are still ethical concerns such as data privacy and algorithmic bias. To fully implement and adopt AI in a beneficial manner, [26] stated that institutions should collaborate and invest in infrastructure, develop inclusive policies and invest in skills training and ethical governance.

### 3.3. Current AI adoption Case Studies in Southern Africa

Artificial Intelligence (AI) is currently being integrated in most Open Distance e-Learning (ODeL) higher and tertiary institutions across Southern Africa to enhance teaching and learning. This study reviewed literature pertaining to the current application of AI in ODeL institutions within Zimbabwe, Zambia, Malawi and South Africa, highlighting specific case studies and their impacts.

Open Distance e-Learning (ODeL) institutions in Zambia are increasingly incorporating Information and Communication Technology (ICT) as well as Artificial Intelligence (AI) to improve teaching and learning. In their study to examine student's experiences with Fourth Industrial Revolution (4IR) in higher learning institutions in Botswana and Zambia, [27] highlighted that several institutions have adopted and are utilizing learning management systems, video conferencing tools and social media platforms. However, their study highlighted that there is need to further integrate new advanced technologies such as Artificial Intelligence (AI), Virtual Reality (VR), and Augmented Reality (AR) to fully utilise the potential of education 4.0. Additionally, their study findings revealed challenges that included adequate infrastructure, limited internet access, and lack of training for both staff members and students.

A study by [27] examined students' experiences with Fourth Industrial Revolution (4IR) technologies in higher learning institutions in Zambia and Botswana. The findings revealed that while institutions have adopted learning management systems, virtual classrooms, video conferencing tools, and social media platforms, there is a need to further incorporate advanced technologies such as AI virtual teaching assistants, and virtual reality (VR) to fully realize the potential of Education 4.0. Challenges identified include inadequate infrastructure, limited internet access, and insufficient training for both faculty and students [28]. According to Himoonga and Phiri (2020), the use e-learning platforms in Zambian tertiary institutions is relatively low due to barriers such as complex systems, inadequate hardware and software resources, and erratic power supply. The studies done in Zambia and Botswana emphasizes the need for strategic investments in infrastructure, policy development, and capacity building to efficiently incorporate AI and ICT in Zambia's ODeL institutions.

#### 3.3.1. Artificial Intelligence (AI) adoption in South Africa

In South Africa, The University of South Africa (UNISA) has been taking a leading role in incorporating Information and Communication Technology (ICT) and exploring Artificial Intelligence (AI) to enhance teaching and learning in its Open Distance e-Learning (ODeL) system. In their recent study to establish the effectiveness of technology in ODeL at UNISA, Msekelwa (2024) revealed that students who effectively made use of technology improved their communication skills and overall academic performance.

The University of South Africa (Unisa) is actively participating in the adoption of artificial intelligence (AI) into its Open Distance e-Learning (ODeL) system [29]. The university on the 6th of September 2024 hosted an AI related webinar titled "Demystifying and destigmatizing AI in module design and development". The webinar focused on how AI can be utilised in the creation of adaptive, student-centered modules that will assist them to achieve its CODeL strategy (comprehensive, open, distance and e-learning). On the same webinar, UNISA's Academic Development Open Virtual Hub (ADOVH) demonstrated an AI powered chatbot named Lwazi, which was developed to help students in as far as administrative and exam issues were concerned. The chatbot offered students real-time responses and personalised support. Discussions on ethical and practical Considerations were also done during the 2023 Open and Distance Learning

(ODeL) Conference. This conference emphasized the need to balance AI adoption with human oversight in teaching and learning practices. Furthermore, in South Africa, the University of Pretoria (UP) also adopted AI applications to enhance teaching and learning. They held workshops that introduced academic staff to AI tools such as ChatGPT, which can be utilised in summarizing complex information, solving mathematical equations, and providing 24/7 tutor support. The initiatives by the institutions are aimed at enriching teaching and learning hence offer personalized assistance to students.

### 3.3.2. Artificial Intelligence (AI) adoption in Malawi

In Malawi higher and tertiary institutions are also actively integrating artificial intelligence (AI) into their Open Distance e-Learning (ODeL) frameworks. The Malawi University of Science and Technology (MUST) through the Centre for Artificial Intelligence and STEAM (CAIST) with support from US, has taken a leading role in the promotion of AI and STEAM education, supporting the country's Vision 2063 for technological advancement (VOA News, 2023).Additionally, students at MUST developed AI- driven projects that includes a deep learning system for rapid measles diagnosis and also a machine learning-based crop recommendation system to help farmers [30]. Similarly, Mzuzu University (MZUNI) established an Open and Distance learning center and is offering e-learning programs through five satellite centers across Malawi.

### 3.3.3. Artificial Intelligence (AI) adoption in Zimbabwe

In Zimbabwe, the Zimbabwe Open University (ZOU) took a leading role in integrating Information and Communication Technology (ICT) in its ODeL framework. The university implemented a Moodle based learning management system called MyVista. The MyVista platform is an e-learning system that assists instructors and students to conduct online teaching and learning activities. Instructors can upload learning materials in various formats and registered students access the learning materials, communicate with peers, lecturers and submit assignments online [31]. In terms of implementing AI, ZOU adopted the education 5.0 model and implemented AI based projects such as an AI tomato disease detection system that also provided remedies to assist local farmers in Zimbabwe. This research project was showcased at the Zimbabwe International Trade Fair in 2024, demonstrating that the university is committed to adopt AI to enhance teaching, learning and community benefit [31]. However, since its full implementation of the MyVista e-

learning system in 2017, both students and staff faced several challenges that include limited ICT resources, limited training, and poor network connectivity to fully utilise the learning management system. Furthermore, recent research points out that the ethical use of AI within university libraries in Zimbabwe show that several institutions, including ZOU, are still in the early stages of AI adoption. There are continuing efforts to draft suitable policies that address challenges related to transparency, data security, and intellectual property protection [32], [33].

University of Zimbabwe which offers blended learning is also taking a leading role in the implementation of AI to enhance teaching and learning. The University of Zimbabwe (UZ) developed an AI tool that incorporated advanced analytics and machine learning algorithms. The tool was used to tailor learning pathways to meet individual student needs [7]. The tool was used to track student performance data in real-time and allowed timely interventions to students who were struggling with their academic work. The AI tool was able to flag students who were at risk of failing based on their submissions and academic performance. Instructors were able to timely offer assistance and resources to struggling students to improve student retention rates. Results obtained from the use of the AI tool indicated a significant improvement in student engagement and overall academic performance, as students felt more engaged and supported in their academic work [7].

### 3.4. Challenges and opportunities realized in the adoption of AI

Open Distance e-Learning (ODeL) institutions in Southern Africa realised several challenges and opportunities in the adoption of AI. This research study highlighted some of the opportunities and challenges faced.

#### 3.4.1. Notable opportunities realised through AI adoption

Higher and Tertiary institutions in Southern Africa that integrated AI into their ODeL systems increased student engagement in learning. An example is The University of Cape Town (UCT) in South Africa, developed an AI- driven chatbot that assisted students to have access to academic resources and support. The chatbot operated 24/7, helping with academic queries, course information, and administrative support. According to Lötter, Benade, and Sutherland (2021), about 70% of students who used the chatbots found out

that it increased interaction, engagement, and satisfaction in resolving their queries. Furthermore, the university gathered data from chatbot interactions with the students, and it assisted them to identify common areas of misperception among students, helping in improved decision making to improve course materials and outreach plans [34], [35].

AI has also been adopted to enhance personalised learning experiences in higher and tertiary institutions in Southern Africa. The University of Zimbabwe (UZ) for example, adopted the blended learning model since the COVID 19 period hence developed an AI based system that incorporated advanced analytics and machine learning algorithms [7]. The system developed was able to track student performance data in real time assisting instructors to identify struggling students and allow timely interventions. The system was able to flag students who were at risk of failing based on submissions and engagements made. Results obtained from the use of the AI system indicated an improvement in overall student engagement, performance and retention, as students felt that they were given sufficient help in their academic journey [7].

The University of Malawi (UNIMA) has adopted AI in their ODeL model of learning to facilitate the management and delivery of distance education courses. UNIMA developed AI tool that automated administrative tasks to allow staff members to focus on student support and content improvement. The AI tool developed utilised natural language processing to provide students with resources and answers on frequently asked questions hence create a collaborative learning and teaching environment. Students were able to interact with their instructors and peers through the AI tool hence improve their engagement and learning experiences. About 85% of the students indicated that AI tool used significantly improved their learning experiences and enhanced teaching and learning. Additionally, The University of Zambia (UNZA) has also adopted AI in its ODeL model of learning by developing an AI tool that promoted personalised learning experience for students enrolled in their ODeL programs [27]. The tool analysed student learning behaviors and interactions, adjusting content delivery based on student's learning style. Students who used the tool reported that the tool promoted autonomy, engagement and motivation in their learning process [36].

Based on the examples cited in this study, AI integration can assist educational policymakers and academics to create teaching and learning environments that lead to increased student engagement, allowing them to learn at their own pace and have control of their learning to understand the subject matter [37], [38]. Furthermore, the integration of AI in higher education ODeL institutions provides personalized learning that accommodates each student's preferences [5].

**3.4.2. Challenges Faced in AI Adoption.**

Research indicates that implementing AI in ODeL models is very beneficial but however the cost of implementing AI technologies is still a huge challenge to several institutions in Southern Africa. Institutions have limited budgets and as a result fail to invest in advanced AI technologies and required support infrastructure [4], [39]. Institutions in higher education lack the finances to continuously provide training to staff members hence AI adoption becomes a challenge [40]. Additionally, institutions of higher and tertiary education lack clear strategic direction in the integration of AI in education. There is no strong leadership, clear strategy and efforts to implement AI leading to skepticism among staff members on the long-term viability of AI adoption to the organization [41].

Higher and Tertiary institutions lack policies and regulations to govern AI adoption [4]. This was supported by [40] who in their study stated that Higher Education institutions face challenges to adopt AI due to ambiguity in policies and regulations. They further stated that currently few institutions have legislation and regulatory frameworks to govern the use of AI [42], [3]. Furthermore, recent research points out that another challenge faced to adopt AI in institutions is the issue of data privacy and ethics [43]. Staff members and students are concerned about how collected data will be protected for privacy and used in an ethical way. There is growing fear that AI might infringe into staff and student privacy, hence lead to misuse of sensitive information [3].

Recent research pointed out that there is a gap in higher and tertiary institutions. Understanding 4IR technologies including AI make it very complex for institutions to implement various technologies [44], [3]. According to [5], AI is still an unexploited resource in higher and tertiary education due to lack of expertise and knowledge sharing.

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Most Higher Education institutions are lagging in very crucial indicators for effective digital transformation due to lack of digital and technological skills as well as low levels of academic success [3],[5]. Institutions are still facing challenges in developing the required infrastructure, training faculty and continuous maintenance of AI systems sometimes due to lack finances and resources [5], [39].

### 3.5. Most Effective AI Interventions in Southern Africa

#### 3.5.1. Intelligent Tutoring Systems (ITS)

The study noted that several AI interventions were done in Southern Africa ODeL institutions but however, most institutions implemented intelligent tutoring systems (ITS), Natural language processing (NPL) chatbots and AI-predictive analytics. Several ODeL institutions are investing more on the development of Intelligent Tutoring Systems maybe to address the challenge of high student instructor ratios, a challenge that is associated by many ODeL institutions in Southern African region. Additionally, ITS systems might be popular among ODeL institutions because assist Universities to continue running in the event of natural disasters such as COVID 19 since they offer adaptive learning paths, and automated instructional assistance. Furthermore, many institutions in countries such as Zimbabwe, Malawi and Zambia are under-resourced hence ITS assists to lesson burdens to instructors but still managing to offer personalised learning experiences to enhance student engagement [45].

#### 3.5.2. NLP Chatbots

Several ODeL institutions are gearing towards enhancing teaching and learning by providing instant feedback to students hence NLP chatbots are widely utilised. With applications such as WhatsApp being popular among many enrolled and prospective students, NLP chatbots assist institutions to support students 24/7 and this can boost their enrolment and assist in student retention to generate revenue especially in resource constrained countries such as Zimbabwe, Malawi and Zambia [45]. Furthermore, Chatbots are very effective in answering frequently asked questions, offer academic guidance and can assist both urban and rural students which in most cases are the goals of ODeL institutions. Gadgets that use WhatsApp for example are widely used in both urban and rural areas hence chatbots developed on that platform reach a wide range of

potential and full-time students. Lastly, unlike ITS, NLP chatbots are easy to develop, deploy and maintain hence that might be the reason most institutions adopted them.

#### 3.5.3. AI-Predictive Tools

AI-predictive tools were also popular in resource constrained countries such as Zimbabwe, Malawi and Zambia. This was because of the need to get insights into the number of students who may be at risk of dropping so that quick interventions may be made. Most institutions in Zambia, Malawi and Zimbabwe enroll many students to fund their operations because of lack of financial support from government. AI analytics will assist in better decision making so that they minimise student dropouts, a factor that directly affects their existence. For instance, studies that were carried out in Zambia and Malawi highlighted that with the intervention of AI powered analytics, more students complete their studies. Additionally, predictive analytics were also popular among several institutions, maybe because they are easy to scale and deploy unlike Intelligent Tutoring Systems (ITS).

### 3.6. Effective Technical Foundations in the Adoption of AI in ODeL

There are several AI tools that can be used to support Open and Distance e-Learning (ODeL) institutions. To develop effective AI tools in ODeL, several technical components need to be considered, and these range from data infrastructure to algorithmic design. There will be a need for robust data collection and management systems that can collect learner data from different sources that include Learning Management Systems (LMS) as well as real-time user interactions platforms. The data collected from the LMS will be used as the training input for machine learning (ML) algorithms such as supervised learning models. The supervised learning models can then be used to perform predictive analytics such as predicting students who are at risk of dropping out or recommending personalized content path [13].

#### 3.6.1. Natural language processing

Natural Language Processing (NLP) is another very important AI technology that can be utilised in ODeL institutions. NLP can be used to develop AI-powered chatbots and virtual assistants that can assist in the provision of real-time academic and administrative support. AI-powered chatbots and virtual assistants can be used to enhance accessibility

and learner engagement in asynchronous environments [46]. Furthermore, there will be a need to invest into Cloud computing infrastructure because it is very important for scalability and real-time AI services. ODeL institutions should implement techniques such as fairness-aware modelling and differential privacy to ensure ethical deployment of AI tools to protect user data [47]. Literature points out that it is very important to utilise open-source AI frameworks such as TensorFlow or PyTorch when developing AI tools to accelerate development and lower costs for ODeL institutions with limited financial resources. Finally, it is recommended that ODeL institutions should consider continuously monitoring AI tools and implement human-in-the-loop systems (HITL) that involve the intervention of humans in AI processes to ensure transparency, reliability, and pedagogical alignment of AI tools in educational environments. By addressing some these very important technical foundations, AI solutions that can be developed will be able to effectively enhance learner experiences and administrative efficacy in Southern African ODeL settings.

### 3.7. Programming and Coding Ideas of Application of AI in ODeL

In recent years, ODeL institutions have developed innovative AI based tools to improve the quality of teaching, learning and administration. Recent literature points out that the AI based tools developed by various institutions in Southern Africa have greatly improved quality of teaching, learning personalization, student engagement, and institutional efficiency [48], [49]. AI assists institutions to develop important tools such as adaptive learning platforms that make use of reinforcement learning algorithms. The adaptive learning platforms adjust content dynamically based on individual student progress, grades, and learning styles, hence promote self-regulated learning and academic success [50], [13]. Furthermore, Institutions are also developing intelligent systems that detect learning styles of students using behavioral data. The system will then deliver visual, auditory, or kinesthetic learning content based on the students' preferences. Additionally, Natural Language Processing (NLP) has been very important in the development of multilingual AI chatbot tutors. Several AI chatbots were developed to provide instant academic support to students in different subjects, especially in complex subjects such as computer programming [51], [52].

ODeL institutions utilised predictive analytics tools using machine learning models such as Random Forests and XGBoost. Random Forests and XGBoost models enabled institutions to quickly identify students who were struggling with their studies and were at risk of dropout and offer timely interventions [53], [39]. Furthermore, AI is being utilised in exam monitoring processes through computer vision-based proctoring tools that are being used to detect questionable student behavior using facial recognition and motion tracking tools [54], [55]. Several AI based systems were developed in Southern African ODeL institutions and most of them utilised open-source frameworks such as PyTorch, TensorFlow and NLP libraries to address challenges peculiar to the region. These AI frameworks and libraries are very important in the creation of systems that address challenges such as lack of resources, limited student instructor interaction, and lack of instant feedback among other challenges [56], [57]

#### 3.7.1. Adaptive Learning with Reinforcement Learning (Q-learning) Use Case in ODeL

Adaptive learning with reinforcement learning, particularly using Q-learning, can be utilised in ODeL where an AI educational system can personalise the learning paths of individual student based on how the individual interacts with the system. Q-learning is a kind of model-free reinforcement learning technique used in ODeL environments. It uses an agent (in this example, an ODeL learning system) to maximize cumulative rewards to learn the best course of action in each environment [58]. In the context of adaptive learning in ODeL, the Learning Management System (LMS) will be the agent, while student interactions with the LMS (like answering questions correctly or incorrectly) will denote the environment's responses [58]. The LMS will constantly observe how students interact and respond to different types of learning content, and in the end learns to recommend the most suitable learning needed by each student, thus enhance engagement and performance over time [6], [59]. Figure 4.1 shows code snippet that simulates how an ODeL learning management system (LMS) can modify learning materials based on the student's expertise in the subject.

The code on Figure 2 simulates how ODeL Learning Management Systems can implement an adaptive learning system that modifies learning content based on the student's proficiency level. On the code states represent the different student learning levels and that includes, Beginner, Intermediate and Advanced levels. On the other hand, Actions on

the code represent the complexity of learning resources and these includes Easy, Medium, Hard. The Q-table is a matrix where the LMS system "learns" which actions yield the best long-term learning outcomes for each state. In the learning process, the algorithm chooses actions randomly (exploration) or based on the past learning which is (exploitation). It then updates the Q-table using the reward system, where better educational choices for example giving an "Easy" task to a beginner are rewarded. Adaptive learning with reinforcement learning, particularly using Q-learning can be utilised to personalise learning pathways of students based on past progress and performance.

```
import numpy as np

# Define states and actions
states = ["Beginner", "Intermediate", "Advanced"]
actions = ["Easy", "Medium", "Hard"]
Q = np. zeros ((3, 3)) # Q-table

alpha = 0.1 # Learning rate
gamma = 0.6 # Discount factor
epsilon = 0.1 # Exploration rate

# Dummy reward function
rewards = np. array ([[10, -10, -20],
[-10, 20, -10],
[-20, -10, 10]])

# Q-learning loop (simplified)
for i in range (1000):
state = np. random. rand (0, 3)

if np. random. rand () < epsilon:
action = np. random. rand (0, 3)
else:
action = np. argmax(Q[state])

reward = rewards [state, action]
next_state = (state + 1) % 3
Q [state, action] = (Q [state, action] + alpha *
(reward + gamma * np.max(Q[next_state]) - Q [state, action]))

print ("Learned Q-table:")
print(Q)
```

**Figure 2.** Adaptive learning system code snippet

### 3.7.2. Student Drop out prediction (Random Forest Classification) Use Case in ODeL

Student dropout prediction is very important in ODeL higher and tertiary education. There is a need for institutions to perform educational data mining to identify students

at risk of dropping their studies early. To perform such tasks, Random Forest Classification can be utilised. Random Forest Classification is an ensemble machine learning method that is very useful in student drop out prediction because it handles both categorical and numerical data very well [60], [61]. Furthermore, it also resists overfitting and provides feature importance. Random Forest Classification operates by constructing several decision trees during training and outputting the class (dropout or not) that is the mode of the predictions from individual trees [8]. This will enable ODeL institutions to quickly identify student learning pattens such as performance, attendance, engagement. Analysis of these patterns will give an insight on students with a likelihood of dropout [16], [62].

```
from sklearn. ensemble import RandomForestClassifier
from sklearn. model_selection import train_test_split
from sklearn. metrics import accuracy_score

# Example dataset
X = [[5, 80], [2, 45], [3, 60], [1, 30]] # [login frequency,
attendance %]
y = [0, 1, 0, 1] # 0 = No dropout, 1 = Dropout

model = RandomForestClassifier ()
X_train, X_test, y_train, y_test = train_test_split (X, y,
test_size=0.25)
model.fit (X_train, y_train)
y_pred = model. predict(X_test)
```

**Figure 3.** Student Dropout Prediction code snippet

The code snippet on Figure 3 shows Random Forest Classification model that can predict student retention risk using machine learning. As shown in Figure 3 the Input Features include the login frequency and attendance percentage. The Random Forest Classifier model is a very powerful ensemble method that builds multiple decision trees and is used for classification and regression tasks. It works by building multiple decision trees during training and produces the majority class(classification) or average predictions(regression) from the trees. As shown on the code snippet, the Random Forest does not rely on a single tree because it can overfit. It builds on several trees, and each tree is trained on a random subset of data and features. The trees will vote, and the majority decision is regarded as the final prediction, hence better generalization and high accuracy. On the code snippet above, the Random Forest Classifier object by default builds 100 decision trees and each tree is trained on a random subset of students and

features. Data is split into two, 75% for training (X_train, Y_train) and 25% for testing (X_test, Y_test). This assists to evaluate how well the model performs on unseen data. On the code, the model.fit (X_train, Y_train) trains the model on the training data. Internally multiple decision trees are created, and each tree makes splits which are decisions. The decisions made are based on login frequency and attendance percentage to predict student dropout. The trained model predicts the outcomes of the test set (y-pred=model. predict(X_test). Print ("accuracy", accuracy_score (y_test, y_pred") compares predicted versus the actual values and prints the accuracy score. Accuracy will be equal to correct predictions divided by the total predictions. The output from the code snippet above will be a binary classification where Dropout (1) or No Dropout (0). The Random Forest Classifier model can assist ODeL institutions to quickly identify students showing signs and disengagements hence proactively intervene.

### 3.7.3. Voice-to-Text with Summarization (SpeechRecognition + Transformers)

Higher and Tertiary ODeL institutions can also utilise Voice-to-text with summarization which is an advanced natural language processing (NLP) task. Voice-to-Text with Summarization task converts spoken language into written text (transcription) and then shrinks it into a short summary [63], [64]. This is very important in higher education ODeL settings, journalism, and meeting documentation. The system comprises two major components. The first component is speech recognition. Its major purpose is to transcribe audio using libraries like SpeechRecognition or APIs such as Google Web Speech. The second component is the text summarization, which can be implemented by transformer-based models such as BART or T5 using the transformers library by Hugging Face [63], [64], [65]. This pipeline allows automation of very long audio processing into meaningful summaries, enhancing productivity and accessibility [63], [66].

```
import speech_recognition as sr
from transformers import pipeline
# Speech-to-text
recognizer = sr. Recognizer ()
with sr. Microphone () as source:
print ("Speak something...")
audio = recognizer. listen(source)
text = recognizer. recognize_google(audio)
# Summarization
summarizer = pipeline("summarization")
summary = summarizer (text, max_length=50, min_length=25, do_sample=False)
print ("Summary:", summary [0] ['summary_text'])
```

**Figure 4.** Voice-to-Text with Summarization code snippet

The code snippet on Figure 4 transcribes spoken content such as lectures and summarizes it for review or revision. SpeechRecognition captures the audio from the microphone and transformers. pipeline("summarisation") uses an NLP model to summarise the transcribed text. A Python library called speech_recognition is used to recognize speech from audio. The transformers library is a library from Hugging Face and pipeline is a high-level interface that performs tasks such as translation and summarisation. The recognizer=sr. Recognizer () creates an instance of the Recognizer class which processes the audio output. The user speaks using a microphone and the audio=recognizer. listen(source) records audio from the microphone until there is silence. The text=recognizer. recognize_google(audio) line of code converts the recorded audio to text using Google's speech recognition API. On the summarization section the summarizer=pipeline("summarization") line of code loads a pre-trained summarization model using Hugging Face's pipeline. The summary=summarizer (text, max_length=50, min_length=25, do_sample=False) line of code generates a summary of transcribed text, controlling how short or long the text can be. The summary generated from the spoken input is printed out by the print ("Summary:" summary [0] ['summary_text']) line of code. In summary this script records a user's voice using a microphone, converts what is said into text, summarizes the text using a machine learning model and finally prints the summary. Voice-to-Text with Summarization can be utilised by ODeL institutions to enable students to automatically generate summarized notes from lectures and voice tutorials for revision purposes.

### 3.7.4. Course Recommendation System

ODeL higher and tertiary institutions can also make use of AI based recommendation systems to assist students to discover relevant courses based on their interests, behavior, or performance. The AI based recommender systems make use of collaborative filtering that can recommend courses or reading material based on what other similar students liked or content-based filtering that recommends based on course attributes and learner profiles [67], [68]. Machine learning algorithms can generate personalised course suggestions based on a student's data such grades, skills level, and completed courses hence improve user experience and learning outcomes [69]. Figure 5 shows a code snippet of a course recommender system.

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```
from sklearn. feature_extraction.text import TfidfVectorizer
from sklearn. metrics. Pairwise import cosine_similarity

courses = ["Introduction to Python", "Advanced Data Science", "Web
Development Basics", "Machine Learning"]
query = "python data science"

vectorizer = TfidfVectorizer ()
tfidf_matrix = vectorizer.fit_transform (courses + [query])
cosine_sim = cosine_similarity (tfidf_matrix [-1], tfidf_matrix [: -
1])
recommended_index = cosine_sim. argsort () [0] [-1]
print ("Recommended course:", courses[recommended_index])
```

**Figure 5.** Course Recommendation code snippet

The code snippet on Figure 5 recommends courses or learning materials based on user preferences or search terms. The TfidfVectorizer converts text into numerical format based on importance (termfrequency). The cosine_similarity compares the user's query with the course content. Data is set up with a list of available courses as well as a query which is a search term or an input of interest from the user. The vectorizer=TfidVectorizer () line of code creates an object called TfidVectorizer.

The fit transform method vectorizes all course titles plus the user query into TF-IDF feature vectors and courses + [query] combines the list of course titles with the query. The line of code cosine_sim=cosine_similarity (tfidf_matrix [-1], tfidf_matrix [: -1]) calculates the cosine similarity between the vector for the query (tfidf_matrix [-1]) and all vectors for the course titles (tfidf_matrix [: -1]) and this will give a similarity score for the query against each course. To find the best match recommended_index=cosine_sim. argsort () [0] [-1] line of code is used. On the system argsort () returns indices that would sort the similarity scores and [-1] picks the index of the course with the highest similarity score. In conclusion, this AI recommender system takes a list of course titles and then accepts a user query. The system then measures similarity between the query and course titles making use of text-based comparisons (TF-IDF + cosine similarity) and then recommends the course that is relevant. The AI recommender system can be utilised in ODeL systems to suggest resources, learning paths as well as elective modules based on students' interests and needs.

### 3.7.5. Simple Chatbot using Natural Language Toolkit (NLTK)

Natural Language Toolkit (NLTK) is an AI technology that can be utilised in ODeL to develop tools like chatbots. Natural Language Toolkit (NLTK) make use of basic Natural language processing (NLP) techniques such as tokenization, stemming, and keyword matching to comprehend and give responses to user input [70], [71]. The Chatbots developed may not be as advanced as transformer-based bots but rule-based chatbots are easy to implement and are very useful in providing guidance to students especially in ODeL settings where physical interaction is sometimes limited. NLTK is very useful in the processing of user input and mapping it to predefined answers using pattern matching or similarity logic [72], [73].

```
import nltk
from nltk. chat. util import Chat, reflections

pairs = [
[r"hi|hello", ["Hello, how can I assist your learning today?"]],
    [r"what is python", ["Python is a high-level, interpreted
programming language."]],
[r"quit", ["Goodbye!"]],
]

chatbot = Chat (pairs, reflections)
chatbot. converse ()
```

**Figure 6.** Natural Language Toolkit code snippet

The code snippet on Figure 6 above shows how Natural Language Toolkit (NLTK) can be utilised to build a simple chatbot that can assist students in ODeL learning environments. The code generally provides basic, predetermined answers to questions that are frequently asked by students. The critical modules that are utilised are The Natural Language Toolkit (nltk) which is a library that works with human language data (text). Additionally, chat is a utility class from NLTK that is used in the building of rule-based chatbots and lastly reflections which is a built-in dictionary that handles common transformations for example (from "I" to "You"). On the code pairs define the chatbot responses. Each item in the list is a regex patten for example ("hi|hello" matches either "hi" or "hello"). So, if the user types hi or hello, the first response will be given which is ["Hello, how can I assist your learning today?"]. The chatbot= chat (pairs, reflections) line of code creates a chat object using the defined pairs and reflections helper and this prepares the bot to match inputs from the users to responses.

The chatbot. converse () line of code starts the chatbot in interactive mode and continually prompts a user for input until they quit. The AI based chatbots are very important to ODeL institutions as they can act as 24/7 virtual assistants for learners that might need assistance outside normal working hours or needing administrative inquiries.

### 3.8. Discussion

The integration of AI in Southern African higher and tertiary institutions has gained momentum especially in the current context of education 5.0. According to [32], [74], this technological phase put emphasis on the significance of technology incorporation and personalized learning, making use of data analytics and AI to tailor learning experiences [25] [75]. The review noted several successful case studies in South Africa, Zimbabwe, Botswana, Zambia and Malawi. However, the study noted that institutions in developing countries such as Zimbabwe, Malawi and Zambia mostly implemented chatbots in their learning environments primarily because they are not costly to implement unlike predictive analytics systems. According to [78], institutions in economically disadvantaged countries face significant infrastructural discrepancies, thus widening the digital divide. Well-resourced institutions like UNISA in South Africa have implemented both chatbots and predictive analytics systems to enhance teaching and learning. UNISA has the capability in terms of the hardware, software and human resources to support advanced AI applications compared to institutions in developing countries around the Southern Africa region. This comparative analysis shows that many institutions are aware of the benefits of AI but there is an uneven progression in the implementation process because institutions' capacity, policy and funding play a pivotal role [78].

The study also identified in the literature that there is minimum collaboration among ODeL institutions across the Southern African region [5], [77]. According to [5] and [77], there is lack of strong regional partnerships and knowledge sharing mechanisms and this can lead to risks such as siloed development and redundant efforts. Since most institutions in the region face similar challenges, the study highlights the need for cross-institutional alliances to share resources such as infrastructure, training, and joint research.

Most literature reviewed had limitations and biases in that it just highlighted the transformative potential of AI, keeping a blind eye on long-term implementation challenges and failures. Additionally, most of the literature reviewed originated from South Africa as compared to other countries such as Zimbabwe, Zambia, Malawi and Botswana. Most of the research sources originated from well-resourced institutions such as UNISA, UCT, and University of Johannesburg and this had the risk of skewing the regional representation of AI adoption trends in the region.

The study also noted that there are recurring ethical concerns as far as AI adoption is concerned in both resourced and under resourced institutions in the region. Literature still highlights concerns towards data privacy, informed consent and algorithmic biases [22], [79]. The risk of data misuse and breaches is very high especially in institutions that lack a robust ethical and legal framework. Institutions are encouraged to advocate for structured models such as the A18-Point model, to guide in the adoption of AI including the development of transparent algorithms, stakeholder engagement and training [79].

Ethical concerns were another recurring theme. Issues such as data privacy, algorithmic bias, and informed consent remain inadequately addressed. The absence of robust ethical and legal frameworks raises the risk of data misuse and breaches, especially in institutions lacking cybersecurity capabilities [22]. To address these concerns, some scholars advocate for structured models such as the A18-Point model [79], which provides a roadmap for responsible AI adoption, including stakeholder engagement, training, and transparent algorithmic design.

While the study was focused on reviewing literature on AI adoption in Open and Distance e-Learning (ODeL) within southern Africa, finding obtained may be related to other regions, especially those regions that have the same socio-economic, educational and infrastructural challenges. Many of the challenges such as limited digital infrastructure, ethical considerations, resistance to change are common challenges beyond the Southern African Region. Other regions in the Sub-Saharan Africa as well as other low to middle income countries in Asia and Latin America could also be facing the same challenges hence findings obtained in the study may offer important lessons on patterns, barriers and enablers to institutions who may want to fuse AI into their ODeL systems. However,

it must be taken note that there will be need for caution in assuming direct transferability because of differences in culture, technological readiness, and policy.

## 4. CONCLUSION

The study noted a growing interest in the adoption of AI among ODeL institutions in Southern Africa. Institutions such as The University of South Africa (UNISA), Zimbabwe Open University (ZOU), Malawi University of Science and Technology (MUST), University of Zimbabwe (UZ), and The University of Cape Town (UCT) have adopted AI to enhance teaching and learning. Literature reviewed highlighted that the implementation of AI by the universities proved to be beneficial especially with personalised learning experiences, enhanced administration, and improved data-driven decision making. However, the adoption process remains inconsistent with major challenges such as lack of proper infrastructure, limited student instructor interaction, digital divide, and lack of skilled personnel cited. Literature reviewed put more emphasis on isolated success stories especially but not taking into consideration issues to do with long term outcomes, scalability and socio-economic differences within the region.

Several studies have stated concerns as far as data privacy and algorithmic bias are concerned, but few addressed the issues in much detail. Literature highlighted the need for the development of regional-specific strategies that promote investment in shared infrastructure and collaboration among universities, policy makers and technology providers. Furthermore, the study recommends that future research should focus on longitudinal studies that will evaluate how AI can be used to bridge the digital divide especially in under-resourced countries such as Zimbabwe, Malawi, and Zambia. Without synchronized efforts and collaboration among ODeL institution to formulate inclusive policy frameworks, the transformative capability of AI in Southern African ODeL systems may remain fundamentally unexploited.

**REFERENCES**

[1] P. Z. Msekelwa, "Effectiveness of technology in Open Distance Learning," Journal of Knowledge Learning and Science Technology ISSN: 2959-6386 (online), vol. 2, no. 1, Apr. 2023, doi: 10.60087/jklst.v02.n01.p70.

[2] UNESCO, Open and distance learning: A guide for policymakers. UNESCO, 2021.

[3] J. S. Lubinga, T. C. Maramura, and T. Masiya, "The Fourth Industrial Revolution Adoption: Challenges in South African Higher Education Institutions," Journal of Culture and Values in Education, vol. 6, no. 2, pp. 1–17, Mar. 2023, doi: 10.46303/jcve.2023.5.

[4] V. Funda and R. Piderit, "A review of the application of artificial intelligence in South African Higher Education," in 2024 Conference on Information Communication Technology and Society, ICTAS 2024 - Proceedings, Institute of Electrical and Electronics Engineers Inc., 2024, pp. 44–50. doi: 10.1109/ICTAS59620.2024.10507113.

[5] S. N. Akinwalere and V. Ivanov, "Artificial Intelligence in Higher Education: Challenges and Opportunities," Border Crossing, vol. 12, no. 1, pp. 1–15, Feb. 2022, doi: 10.33182/bc.v12i1.2019.

[6] R. Dlamini and N. Ndzinisa, "Towards a critical discourse on artificial intelligence and its misalignment in sub-Saharan Africa: Through an equality, equity, and decoloniality lens," Journal of Education, no. 98, pp. 42–61, Mar. 2025, doi: 10.17159/2520-

[7] N. Nyoni and F. S. Nhamo, "The integration of artificial intelligence in enhancing learning experiences at the University of Zimbabwe," Journal of Educational Technology Development and Exchange, vol. 15, no. 1, pp. 52–68, 2022.

[8] K. K. Patel and K. Amin, "Predictive Modeling of Dropout in MOOCs Using Machine Learning Techniques," International Journal of Intelligent Systems and Applications in Engineering, vol. 12, no. 4, pp. 436–443, 2024.

[9] S. Patel and M. Ragolane, "The Implementation of Artificial Intelligence in South African Higher Education Institutions: Opportunities and Challenges," Technium Education and Humanities, vol. 9, pp. 51-65, 2024.

[10] B. Nkambule, S. Ngubane, and S. Mncube, "Learning Management System (LMS) for Academic Inclusion and Learning Agency: An Interpretive Review of Technoprogressivism in ODL Instructional Technology Policy," Journal of Education, Society & Multiculturalism, vol. 4, no. 2, pp. 48–84, Dec. 2023, doi: 10.2478/jesm-2023-0018.

[11] L. Mncube, M. Tanner, and W. Chigona, "The Commodification Of Open Educational Resources for Teaching and Learning By Academics in An Open Distance E-Learning Institution," in Proceedings of the 1st Virtual Conference on Implications of Information and Digital Technologies for Development, 2021.

[12] S. Maré and A. T. Mutezo, "The effectiveness of e-tutoring in an open and distance e-learning environment: evidence from the university of south Africa," Open Learning, vol. 36, no. 2, pp. 164–180, 2021, doi: 10.1080/02680513.2020.1717941.

[13] M. Chassignol, A. Khoroshavin, A. Klimova, and A. Bilyatdinova, "Artificial Intelligence trends in education: A narrative overview," in Procedia Computer Science, Elsevier B.V., 2018, pp. 16–24. doi: 10.1016/j.procs.2018.08.233.

[14] .S. Department of Education, Office of Educational Technology, *Artificial Intelligence and the Future of Teaching and Learning: Insights and Recommendations*. Washington, DC, USA: U.S. Department of Education, 2023.

[15] A. Mbangeleli, N. Busiswa, and V. Funda, "Mapping the Evidence Around the Use of AI-Powered Tools in South African Universities: A Systematic Review," International Conference on Education Research, vol. 1, no. 1, pp. 149-158, 2024.

[16] A. R. Moonasamy and G. M. Naidoo, "Digital Learning: Challenges experienced by South African university students' during the COVID-19 pandemic," The Independent Journal of Teaching and Learning, vol. 17, no. 2, pp. 76-90, 2022.

[17] S. J. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 3rd ed. Upper Saddle River, NJ, USA: Pearson Education, Inc., 2010.

[18] M. Ragolane and S. Patel, "Transforming Educ-AI-tion in South Africa: Can AI-Driven Grading Transform the Future of Higher Education?" Journal of Education and Teaching Methods, vol. 3, no. 1, pp. 26–51, Aug. 2024, doi: 10.58425/jetm.v3i1.267.

[19] M. P. Ntsobi and B. J. Mwale, "Revolutionising teaching and learning through AI: A case study of South Africa," *Asian Journal of Social Science and Management Technology*, vol. 6, no. 5, 2024.

[20] E. Mousavinasab, N. Zarifsanaiey, S. R. Niakan Kalhori, M. Rakhshan, L. Keikha, and M. Ghazi Saeedi, "Intelligent tutoring systems: A systematic review of characteristics, applications, and evaluation methods," *Interactive Learning Environments*, vol. 29, no. 1, pp. 142–163, 2021, doi: 10.1080/10494820.2018.1558257.

[21] O. A. G. Opesemowo and V. Adekomaya, "Harnessing Artificial Intelligence for Advancing Sustainable Development Goals in South Africa's Higher Education System: A Qualitative Study," *International Journal of Learning, Teaching and Educational Research*, vol. 23, no. 3, pp. 67–86, Mar. 2024, doi: 10.26803/ijlter.23.3.4.

[22] V. Funda, N. Busiswa, and A. Mbangeleli, "Artificial Intelligence (AI) as a Tool to Address Academic Challenges in South African Higher Education," *International Journal of Learning, Teaching and Educational Research*, vol. 23, no. 11, pp. 520–537, Nov. 2024, doi: 10.26803/ijlter.23.11.27

[23] M. M. van Wyk, "Postgraduate students' voices on leveraging Grammarly as an AI-powered tool in academic writing," *Journal of Education*, no. 98, pp. 103–123, Mar. 2025, doi: 10.17159/2520-9868/i98a06.

[24] L. Göçmez and R. Okur, "Artificial Intelligence Applications in Open and Distance Education: A Systematic Review of the Articles (2007-2021)," *Asian Journal of Distance Education*, vol. 18, no. 1, p. 2023.

[25] N. B. Khoalenyane and O. A. Ajani, "A Systematic Review of Artificial Intelligence in Higher Education-South Africa," Social Sciences and Education Research Review, vol. 11, pp. 17–26, 2024, doi: 10.5281/zenodo.15258127.

[26] J. Nielsen, [26] V. Mqaqa, "Embracing Artificial Intelligence in Higher Education: Opportunities and Challenges for a South African University of Technology," *in 2024 IEEE International Smart Cities Conference (ISC2), IEEE*, Oct. 2024, pp. 1–6. doi: 10.1109/ISC260477.2024.11004275.

[27] L. Shonhe, P. Jain, and A. Akakandelwa, "Students' experiences with the utilisation of the 4IR technologies in online learning: a case study of institutions of higher learning in Botswana and Zambia," *Regional Journal of Information and Knowledge Management*, vol. 8, no. 2, pp. 81-100, 2023.

[28] D. vimbwandu Sanoto, J. A. Kasozi, and F. Omal, "The E-Tutor in the New Normal: Analysing the Changing Roles of Tutoring in an ODeL Environment during and post Covid-19," *International Journal of Educational Development in Africa*, Aug. 2023, doi: 10.25159/2312-3540/12135.

[29] M. D. Tshelane, "Troubling artificial intelligence space to reflect on sustainable curriculum practices and the emergent cyborg identities among postgraduate students," *Interdisciplinary Journal of Sociality Studies*, vol. 5, no. 2, Art. no. a01, 2025.

[30] MUST, "MUST leads AI revolution with groundbreaking innovations." Accessed: May 24, 2025. [Online]. Available: https://www.must.ac.mw

[31] ZOU, "Minister of Higher Education commends Zimbabwe Open University's innovative projects at ZITF 2024," ZOU. Accessed: May 23, 2025. [Online]. Available: https://zou.ac.zw

[32] S. Tsekea and E. Mandoga, "The ethics of artificial intelligence use in university libraries in Zimbabwe," *Front Res Metr Anal*, vol. 9, 2024, doi: 10.3389/frma.2024.1522423.

[33] J. Hlongwane, G. N. Shava, A. Mangena, and T. Muzari, "Towards the integration of artificial intelligence in higher education, challenges and opportunities: The African context, a case of Zimbabwe," Int J Res Innov Soc Sci, vol. 8, no. 3S, pp. 417-435, 2024.

[34] S. Saúde, J. P. Barros, and I. Almeida, "Impacts of Generative Artificial Intelligence in Higher Education: Research Trends and Students' Perceptions," *Soc Sci*, vol. 13, no. 8, Aug. 2024, doi: 10.3390/socsci13080410.

[35] R. Berondo, "Harnessing the power of artificial intelligence for personalized learning in education," *European Chemical Bulletin*, vol. 12, no. 10, pp. 1243–1251, 2023, doi: 10.48047/ecb/2023.12.10.0892023.30/06/2023.

[36] F. Ukobizaba, G. Nizeyimana, and A. Mukuka, "Assessment Strategies for Enhancing Students' Mathematical Problem-solving Skills: A Review of Literature," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 17, no. 3, pp. 1–10, 2021, doi: 10.29333/ejmste/9728.

[37] M. Treve, "Integrating Artificial Intelligence in Education: Impacts on Student Learning and Innovation," *International Journal of Vocational Education and Training Research*, vol. 10, no. 2, pp. 61–69, Dec. 2024, doi: 10.11648/j.ijvetr.20241002.14.

[38] S. Asoke and M. Chinmoy, *Artificial Intelligence in Education: Revolutionizing Learning and Teaching*. Red Shine, 2024.

[39] M. C. Maphalala and O. T. Adigun, "Academics' experience of implementing e-learning in a south African higher education institution," *International Journal of Higher Education*, vol. 10, no. 1, pp. 1–13, 2020, doi: 10.5430/ijhe. v10n1p1.

[40] A. Dewa, "Artificial intelligence for educational sustainability in the South African school system: A bibliometric analysis and literature review," *International Journal of Education and Development using Information and Communication Technology*, vol. 20, no. 3, pp. 60–78, 2024.

[41] D. Vale-Cruz, P. Munoz-Chavez, and R. Contreras, "Navigating the Fourth Industrial Revolution: Empowering socio-technical organizations with data-driven business intelligence systems," *Data-Driven Business Intelligence Systems for Socio-Technical Organizations*, pp. 1–27, 2024, doi: 10.4018/979-8-3693-1210-0.ch001

[42] J. Chigwada, "A proposed framework for a digital literacy course for artificial intelligence in academic libraries," *South African Journal of Library and Information Science*, 2024, doi: 10.7553/90-2-2388.

[43] T. Pitso, M. Tjabane, A. Pillay, and T. P. Bojabotseha, "Post-Covid-19 Universities: Opportunities And Challenges For Technology-Assisted Education," *South African Journal of Higher Education*, vol. 38, pp. 150–175, 2024, doi: 10.20853/38-3-6356.

[44] T. Bosch et al., "South African university students' use of AI-powered tools for engaged learning." Medium. Accessed: May 23, 2025. [Online]. Available: https://ssrn.com/abstract=4595655

[45] M. Nyirenda and M. Mumbi, "Towards Automated Assessment of Learning Management Systems in Higher Education Institutions in Zambia," *Open Journal of Applied Sciences*, vol. 14, no. 5, pp. 1279–1294, 2024.

[46] N. B. Khoalenyane and O. A. Ajani, "A Systematic Review of Artificial Intelligence in Higher Education-South Africa," *Social Sciences and Education Research Review*, vol. 11, pp. 17–26, 2024, doi: 10.5281/zenodo.

[47] S. M. Maistry and U. G. Singh, "Faculty perspectives on the role of ChatGPT-4.0 in higher education assessments," *Journal of Education*, no. 98, pp. 86–102, Mar. 2025, doi: 10.17159/2520-9868/i98a05.

[48] P. E. Saal, K. Chetty, N. Ntshayintshayi, T. Moosa, and N. Masuku, "A scoping review of the integration of artificial intelligence in primary and secondary schools from 2020 to 2024: Policy implications for South Africa," *Journal of Education*, no. 98, pp. 62–85, Mar. 2025, doi: 10.17159/2520-9868/i98a04.

[49] C. N. Jatileni, I. T. Sanusi, S. A. Olaleye, M. A. Ayanwale, F. J. Agbo, and P. B. Oyelere, "Artificial intelligence in compulsory level of education: perspectives from Namibian in-service teachers," *Educ Inf Technol (Dordr)*, vol. 29, no. 10, pp. 12569–12596, Jul. 2024, doi: 10.1007/s10639-023-12341-z.

[50] M. Modiba and P. Ngulube, "Artificial intelligence for the management of library and information services in academic libraries in the Fifth Industrial Revolution," *Innovation: Journal of Appropriate Librarianship and Information Work in Southern Africa*, vol. 68, pp. 1–15, 2024.

[51] P. du Preez, L. le Grange, and A. Visser, "AI and higher education: A diffractive reading," *Journal of Education*, no. 98, pp. 5–7, Mar. 2025, doi: 10.17159/2520-9868/i98a01.

[52] W. Holmes, M. Bialik, and C. Fadel, *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning*. Boston, MA, USA: Center for Curriculum Redesign, 2019.

[53] F. O. Egara, M. Mosimege, and M. Mosia, "Secondary school students' perceptions of their usage of artificial intelligence-based ChatGPT in mathematics learning," *Journal of Education*, no. 98, pp. 124–146, Mar. 2025, doi: 10.17159/2520-9868/i98a07.

[54] S. Satre, S. Patil, T. Mane, V. Molawade, T. Gawand, and A. Mishra, "Online Exam Proctoring System Based on Artificial Intelligence," *in Proceedings of 2023 International Conference on Signal Processing, Computation, Electronics, Power and Telecommunication, IConSCEPT 2023*, Institute of Electrical and Electronics Engineers Inc., 2023. doi: 10.1109/IConSCEPT57958.2023.10170577.

[55] S. Aurelia, R. Thanuja, S. Chowdhury, and Y. C. Hu, "AI-based online proctoring: a review of the state-of-the-art techniques and open challenges," *Multimed Tools Appl*, vol. 83, no. 11, pp. 31805–31827, Mar. 2024, doi: 10.1007/s11042-023-16714-x.

[56] D. A. Aksoy and E. Kursun, "Behind the Scenes: A Critical Perspective on GenAI and Open Educational Practices," *Open Praxis*, vol. 16, no. 3, pp. 457–470, 2024, doi: 10.55982/openpraxis.16.3.674.

[57] S. L. Boateng et al., "Mapping the Research on Artificial Intelligence and Entrepreneurship: A Bibliometric Review from Scopus Database," *International Journal of E-Entrepreneurship and Innovation*, vol. 14, no. 1, pp. 1–24, 2024, doi: 10.4018/IJEEI.343790.

[58] G. Li, X. Wang, and M. Li, "A review of recent trends and industry prospects for artificial intelligence technologies," in *Proc. 2021 8th International Conference on Behavioral and Social Computing (BESC)*, Oct. 2021, pp. 1–7.

[59] S. Cross and J. Feldman, "Artificial intelligence in education: Considerations for South African schooling," *Journal of Education*, no. 98, pp. 27–41, Mar. 2025, doi: 10.17159/2520-9868/i98a02.

[60] Ö. Bezek Güre, "Classification of Students Dropout Status Using the Random Forest Method," *International Journal of Eurasia Social Sciences*, Jan. 2024, doi: 10.35826/ijoess.4507.

[61] F. Torres-Cruz et al., "Prediction of university dropouts through random forest-based models," *Journal of Advanced Pharmacy Education and Research*, vol. 15, no. 1, pp. 78–83, 2025, doi: 10.51847/PFB18QB60J.

[62] S. A. Sulak and N. Koklu, "Predicting student dropout using machine learning algorithms," *Intelligent Methods in Engineering Sciences*, vol. 3, no. 3, pp. 91–98, 2024.

[63] N. S. Mamatov, N. A. Niyozmatova, S. S. Abdullaev, A. N. Samijonov, and K. K. Erejepov, "Speech recognition based on transformer neural networks," in *Proc. 2021 International Conference on Information Science and Communications Technologies (ICISCT)*, Nov. 2021, pp. 1–5.

[64] G. Lokare, "Text summarization with Hugging Face Transformers: A beginner's guide," Medium. Accessed: May 23, 2025. [Online]. Available: https://medium.com/@lokaregns/text-summarization-with-hugging-face-transformers-a-beginners-guide-9e6c319bb5ed

[65] R. Gandhi, A. Saini, and S. Gaikwad, "A framework for abstractive text summarization using Hugging Face transformers," in *Proc. 2024 14th International Conference on Cloud Computing, Data Science & Engineering (Confluence)*, Jan. 2024, pp. 690–695.

[66] T. Wolf *et al.*, "Transformers: State-of-the-art natural language processing," in *Proc. 2020 Conference on Empirical Methods in Natural Language Processing: System Demonstrations*, Oct. 2020, pp. 38–45.

[67] B. Jeong and K. J. Lee, "NLP-based recommendation approach for diverse service generation," *IEEE Access*, vol. 12, pp. 14260–14274, 2024.

[68] B. Mondal, O. Patra, S. Mishra, and P. Patra, "A course recommendation system based on grades," in *Proc. 2020 International Conference on Computer Science, Engineering and Applications (ICCSEA)*, Mar. 2020, pp. 1–5.

[69] C. O. Nja et al., "Adoption of artificial intelligence in science teaching: From the vantage point of the African science teachers," *Smart Learning Environments*, vol. 10, no. 1, Dec. 2023, doi: 10.1186/s40561-023-00261-x.

[70] A. Nair, "How does a simple chatbot with NLTK work?" 2019. Accessed: May 23, 2025. [Online]. Available: https://analyticsindiamag.com

[71] R. K. Thodupunuri and A. Akarapu, "Chatbot Application Using NLTK and Keras," 2024, doi: 10.13140/RG.2.2.11169.01124.

[72] S. Raj, *Building Chatbots with Python: Using Natural Language Processing and Machine Learning*. Berkeley, CA, USA: Apress, 2019.

[73] L. Mulaudzi and J. Hamilton, "Student perspectives on optimising AI tools to enhance personalised learning in higher education," *Interdisciplinary Journal of Education Research*, vol. 6, no. s1, pp. 1–15, Sep. 2024, doi: 10.38140/ijer-2024.vol6.s1.03.

[74] N. Mavuso and O. Olaitan, "Education 5.0: Is South African Higher Education Ready?" *EPiC Series in Education Science*, vol. 6, pp. 203–215, 2024.

[75] A. Zouhri and M. El Mallahi, "Improving Teaching Using Artificial Intelligence and Augmented Reality," *Journal of Automation, Mobile Robotics and Intelligent Systems*, vol. 18, no. 2, pp. 57–61, Jun. 2024, doi: 10.14313/jamris/2-2024/13.

[76] L. Bennett and A. Abusalem, "Artificial Intelligence (AI) and its Potential Impact on the Future of Higher Education," *Athens Journal of Education*, vol. 11, no. 3, pp. 195–212, Aug. 2024, doi: 10.30958/aje.11-3-2.

[77] M. Tanjga, "E-learning and the Use of AI: A Review of Current Practices and Future Directions," May 10, 2023. doi: 10.32388/AP0208.

[78] Chirume and S. Thondhlana, "The Use of Zimbabwe Open University's MyVista Platform in E-Communication, Accessing and Uploading Learning Materials, and Assessing Students' Work," *African Educational Research Journal*, vol. 7, no. 1, pp. 1-13, 2019.

[79] A. Bozkurt et al., "The Manifesto for Teaching and Learning in a Time of Generative AI: A Critical Collective Stance to Better Navigate the Future," *Open Praxis*, vol. 16, no. 4, pp. 487–513, Nov. 2024, doi: 10.55982/openpraxis.16.4.777.