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Exploring the Roles of AI-powered e-Tutors in Enhancing Self-Directed Learning in Open Distance e-Learning Courses

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Abstract: Artificial Intelligence (AI) has ushered in a transformative era in education, particularly in the context of Open Distance e-Learning (ODeL). This paper explores the role of AI-powered e-tutors and their potential to revolutionise self-directed learning among students in ODeL courses in South Africa. Self-directed learning, a fundamental pillar of distance education, requires students to be proactive, independent, and motivated. Numerous studies in the fields of AI, ODeL, and Self-Directed Learning (SDL) were reviewed, including case studies involving ODeL institutions, to understand the role of AI-powered e-tutors. This research provides practical insights into using AI-powered e-tutoring to foster self-directed learning. The study allowed for the collection of relevant literature on the given topic that fits the pre-specified eligibility criteria and answers the formulated research questions. The findings underscore the transformative potential of AI-powered e-tutors, including personalised learning experiences, adaptive feedback, real-time support, increased learner engagement and motivation, and enhanced academic performance. The paper also addresses the practical challenges and limitations of implementing AI-powered e-tutoring, such as technology access, data privacy, and the continuous improvement of AI algorithms. The study contributes to the expanding knowledge of AI in education, providing practical insights for academics, policymakers, and technology developers, equipping them with the necessary information to leverage AI to strengthen self-directed learning in ODeL environments. It also outlines the practical implications for future research and practice, highlighting the potential of AI to revolutionise distance learning and empower learners to take control of their educational journeys.

Keywords: Artificial intelligence, self-directed learning, open distance e-learning, e-tutoring, personalised learning.

1. Introduction

Education is regarded as a right, and the state, using reasonable measures, must make it progressively available and accessible (McConnachie, 2012; Arendse, 2020). The government of South Africa has identified open distance e-learning (ODeL) as a solution for addressing this aspiration, as espoused in the Constitution of the Republic of South Africa. Section 29 states that everyone has the right to basic education, including adult basic education, and to further education, which the state, through reasonable measures, must make progressively available and accessible (McConnachie, 2012). By applying the principle of equity, higher education institutions can uphold education as a human right for all citizens, enabling them to develop their full potential (Ngubane-Mokiwa, 2015). ODeL remains the most convenient and suitable approach to achieving this. It involves the utilisation of innovative digital technologies and interlinked facilities to address the issue of access and the optimal use of e-learning resources, thereby enhancing the quality of teaching, learning, and research practices, irrespective of distance and location (Ngubane-Mokiwa, 2017; Ngubane-Mokiwa & Letseka, 2015). At the centre of ODeL lies the economic and social aspiration of a learner-centred approach to delivering competent educational content driven by the principles of

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flexibility and reliable provision of digital platforms under the guidance of e-learning tutors. E-learning platforms have opened new opportunities within the academic community, owing to the various learning benefits achieved through studying without spatial or temporal limitations. For example, e-learning has created significant opportunities for students to take advantage of the flexibility offered by ODeL, allowing them to learn while working. ODeL is a digitally innovative educational model used globally to make education accessible and affordable for many populations (Maphosa & Bhebhe, 2019). It has created opportunities for students to access alternative learning modes while interacting with peers globally (Zhang et al., 2019). In other words, ODeL removes barriers to education, making it accessible to diverse students, regardless of their geographical location, socioeconomic status, or time constraints.

Significantly, AI-powered e-tutors provide a learning avenue and opportunities for countless individuals who cannot attend traditional school-based forms of learning or who have impairments that prevent them from entering formal educational settings (Zhu & Bonk, 2022). Moreover, it can be argued that the availability of AI-powered e-tutors supplements established educational frameworks, increasing the accessibility and efficacy of learning for everyone. AI-powered e-tutoring systems are defined by Khazanchi and Khazanchi (2021) as computer-based programmes designed to replicate one-on-one human tutoring using AI. For example, AI-powered e-tutors offer scalable, customised, and engaging learning experiences in education. This study seeks to explore the role of AI-powered e-tutors and provide critical insights on how the integration of AI in education has brought significant changes to the learning and teaching processes. Within the framework of ODeL, this paper will discuss AI-powered e-tutors, which hold great promise for revolutionising the field of higher education when self-directed learning (SDL) philosophy and principles are adopted and implemented.

1.1 The role of ODeL universities

ODeL institutions are premised on the idea that education should address society's most pressing issues, such as quality education and skills development, and that no student must be left behind. Studies conducted by Maphalala and Adigun (2021) and Zaid and Alabi (2021) indicate the importance of employing the services of e-tutors who are competent in addressing learners' diverse needs, particularly in contexts where connectivity and access remain challenges that must be confronted and addressed swiftly. Evidence suggests that the ODeL environment continues to champion innovation, with unique and sophisticated features such as asynchronous learning, geographical independence, and accessibility for non-traditional learners being pioneered. A partnership between the government and the private sector has broadened the long-standing aspiration of helping students receive quality education by providing support for vulnerable students and increasing throughput (Anakrire, 2024; Maphalala et al., 2023; Tanyanyiwa & Madobi, 2021). At the heart of ODeL is the development of reliable and competent learning management systems (LMS), such as Moodle, powered by AI algorithms capable of assisting e-tutors in guiding students to navigate complex information management and achieve their learning goals.

The University of South Africa (Unisa) pioneered the adoption of e-learning in 2013, predicting the need to introduce AI-powered e-tutors to assist students in the ODeL environment (Letseka et al., 2018; Mbatha, 2013). The speed with which AI was introduced into the academic environment necessitated sufficient skills to promote its existence while safeguarding its integrity within the ODeL context (Ferrein & Meyer, 2012). While academics and tutors were catching up with the latest educational technologies, AI grew rapidly, presenting unique challenges and opportunities for e-tutors to utilise LMS for teaching and learning. Wakahiu and Kangethe (2014) and Tanyanyiwa and Madobi (2021) assert that the growth of AI offers promising capabilities and opportunities for both academics and students, who should understand the benefits of using AI to promote self-directed learning (SDL) in the ODeL environment. Although studies by Sedio (2022) and Lalitha and Sreeja

(2020) downplay the effectiveness of e-tutors, their presence can illuminate the changing nature of AI in contributing to academic writing and clarify the dangers of using AI to engage in academic dishonesty.

1.2 The evolution of AI-powered e-tutors in ODeL universities

The popularity of ODeL on the African continent has led to ambitious yet necessary changes aimed at revolutionising AI-powered e-tutors. The introduction of e-tutors significantly enhances the prospects of promoting SDL approaches that are student-centric, accessible, and highly efficient in catering to diverse contexts. In relation to fostering vibrant SDL activation among ODeL students, scholars such as Lalitha and Sreeja (2020) predicted the emergence of an AI-activated e-tutor capable of developing problem-solving, critical thinking, and innovation in students. Bozkurt and Sharma (2020) demonstrate that ODeL's presence on digital platforms allows learners to access course materials and engage in educational activities anywhere and at any time. However, despite its advantages, ODeL poses significant challenges for learners who may struggle with SDL due to factors such as limited access to support, lack of immediate feedback, and difficulties in maintaining engagement (Bozkurt & Sharma, 2020).

The dominance of e-learning pedagogies in both contact and ODeL environments continues to challenge the effectiveness of SDL in shaping adult learning. This learning approach implies the need for learner-centred methods that provide a lifelong learning strategy for the ODeL environment (Lalitha & Sreeja, 2020; Maphalala et al., 2023). An SDL strategy in ODeL enables students to adopt a more personalised learning approach by first diagnosing their needs, learning goals, and plans, identifying their e-learning requirements, and then implementing and evaluating the outcomes (Lalitha & Sreeja, 2020). Scholars generally maintain that learners in ODeL adopt an SDL approach to acquire knowledge independently of AI e-tutors or peers, striving to develop the new skills necessary to succeed in their learning endeavours. The consensus derived from studies conducted by Lin et al. (2023) and Bozkurt and Sharma (2020) is that AI-based tutoring systems comprise a multidimensional and multifaceted approach, bridging the gap between teachers and students through innovative platforms connected to student LMS. The importance of SDL skills in ODeL environments is underscored, as learners must often manage their education without the immediate presence of a teacher. Common challenges students face in SDL include time management, motivation, and access to support.

Within the ODeL framework, sustainable education implies applying rigorous AI-powered algorithms to enhance each student's learning experience (Lin et al., 2023). AI-integrated tutoring systems are designed to use natural algorithms that accelerate processing and machine learning techniques that assess and analyse student responses in real-time while providing feedback on their learning behaviour. However, many researchers, such as Sedio (2022), have identified patterns of unintended, questionable results generated by AI and machine learning algorithms, which may cause harm. According to Sedio, AI in education has evolved, providing solutions for research, development, and the evaluation of computer software that improves teaching and learning. Lin et al. (2023) maintain that the AI algorithms and personalised tutors developed are intended to address individual students' needs and, at times, teach groups of students. The goal of AI is to contribute to the theory of learning underpinned by AI techniques to understand teaching and learning within the ODeL environment (Lin et al., 2023; Maphalala et al., 2023). It has been reported that AI technology can provide solutions to complex challenges through intelligent tutors. Intelligent tutors could interpret intricate student responses, learn as they operate, discern where and why student understanding has faltered, and offer hints (Lin et al., 2023).

Within the ODeL framework, AI-powered e-tutors have significantly contributed to the advancement of Self-Directed Learning (SDL) by allowing students to study at their own pace. Additionally, they can choose when and where to learn. With enrolments in ODeL institutions and

other types of online courses skyrocketing, it is important that students possess the skills required to engage in SDL (Zhu & Bonk, 2022). Zhu and Bonk further state that students become more purposeful, strategic, and goal-oriented when engaged in SDL. Morris and Rohs (2021) and Maphalala et al. (2021) define SDL as holding students accountable for their education, including organising, carrying out, and reviewing various parts of their learning process. SDL is a learning process in which students oversee their learning objectives and needs, plan their actions, seek out resources, overcome obstacles, and keep track of their progress (Murniati et al., 2023). Notably, when enrolled in ODeL or any other type of online course, students should be fully aware of their engagement, as there is no facilitator to continuously remind them what and how to learn.

1.3 SDL critical skills needed in the ODeL institutions

Bhandari et al. (2020) revealed that although SDL skills are important in ODeL contexts, most students believed they could not develop SDL abilities unless they were trained on how to use them. For example, students required assistance in locating appropriate learning materials and successfully applying SDL while also needing to possess motivation and time management skills. Zhu and Bonk (2022) affirm the findings of Bhandari et al. when they mention that it is vital for students to be savvy regarding digital technologies and to have the SDL skills required to improve their studies and personal growth. Despite its benefits, ODeL presents serious obstacles for students who may struggle with SDL, as access to help may be difficult, feedback may be delayed, and students may have trouble maintaining interest. For instance, ODeL cannot accommodate students in varied conditions, aligning with the above narrative (Zongozzi, 2023). Zongozzi further argues that high student dropout rates present a challenge, particularly in ODeL institutions in South Africa. Student success and retention are negatively affected by poorly designed ODeL systems, and the necessity for such systems to meet the requirements of diverse students increases the likelihood that some students may drop out (Nsamba & Makoe, 2017).

Although there are some obstacles to SDL and ODeL, introducing students to them has more advantages than disadvantages. The above narratives clearly show that using AI-powered e-tutors to enhance SDL in ODeL courses involves leveraging various features and strategies that empower learners to take control of their educational journey. For example, Zhu and Bonk (2022) suggest the following 15 premises as the basis for promoting SDL in the AI-powered e-tutor context of ODeL institutions. These premises are stated in numerical order as follows: (1) help students set their own learning goals, (2) encourage learners to make plans, (3) offer flexible timelines, (4) highlight estimated time frames, (5) embed tasks and activities to form a learning community, (6) supply timely and constructive feedback, (7) embed quizzes for self-assessment, (8) craft visuals showing work progress and tasks completed, (9) provide reflection questions, (10) design time-sensitive learning units, (11) make optional learning materials and self-selection options available, (12) create a structured learning environment, including weekly overviews, (13) ensure that lectures are recorded with captions added, (14) insert application exercises for putting the course material into practice, and (15) use gamification to support SDL. Such advice is especially vital in depersonalised environments. By incorporating Zhu and Bonk's strategies, AI-powered e-tutor environments can effectively promote SDL, helping learners become more independent, motivated, and capable of managing their educational journeys.

The study aimed to explore the role of AI-powered e-tutors in enhancing SDL in ODeL courses, addressing existing gaps in the literature and contributing to the broader field of educational technology. By investigating how AI-powered e-tutors support SDL, this study seeks to provide valuable insights for educators, policymakers, and technology developers while offering practical solutions to the AI challenges facing ODeL institutions. The following research questions guided this study:

- How do AI-powered e-tutors enhance SDL in ODeL courses?

- What are the benefits and challenges of using AI-powered e-tutors to promote SDL?
- How do AI-powered e-tutors influence learner engagement, motivation and academic performance in ODeL environments?

2. Theoretical Framework

This study is grounded in two fundamental theoretical frameworks: constructivist learning theory and self-determination theory (SDT). Constructivist learning theory posits that learners construct knowledge through active engagement and interaction with their environment rather than passively receiving information. This theory, advanced by theorists Jean Piaget and Lev Vygotsky, emphasises the importance of learners being active participants in their learning process and constructing their understanding based on their experiences and prior knowledge (Ertmer & Newby, 2013). Constructivist learning theory provided all the tenets needed to understand the active engagement of students in their learning process but was short of one tenet called motivation, which was provided by SDT. Thus, this study preferred these two theories because they equate learning with creating meaning from experience and underscore the importance of motivation in the learning process as provided by SDT (Bednar et al., 1991; Thampinathan, 2022). According to these theories, the role of the teacher remains to guide the learning process while learners create knowledge through interaction and later attempt to integrate it into existing knowledge (Maré & Mutezo, 2021).

In the context of AI-powered e-tutors, constructivist learning theory underpins the design and functionality of these systems to facilitate SDL. This perspective is supported by a study conducted by Isik (2018) demonstrating how students use a constructivist approach that focuses on the mind and is based on developing cognitive skills. Guan et al. (2020) argue that AI-powered e-tutors create interactive and adaptive learning environments that respond to individual learner needs, promoting exploration, critical thinking, and problem-solving. By providing personalised feedback and resources, these e-tutors enable learners to engage with the content actively, reflect on their learning, and build new knowledge on their existing cognitive frameworks. This aligns with the constructivist emphasis on the learner's active role in knowledge construction and the importance of social interaction in learning processes; as discussed by Guan et al. (2020), AI-powered e-tutors can simulate interactive dialogues and collaborative activities. SDT, developed by Ryan and Deci (2000), focuses on the motivation behind individuals' choices in the absence of external influence and interference. Later, Ryan and Deci used SDT to identify three innate psychological needs – autonomy, competence, and relatedness – which are essential for fostering intrinsic motivation and SDL (Ryan & Deci, 2020). Ryan and Deci also argue that when these three needs are satisfied, they yield enhanced self-motivation and mental health, and when thwarted, lead to diminished motivation and well-being.

AI-powered e-tutors can enhance self-directed learning by addressing three fundamental psychological needs (Marquardson, 2024; Lin, 2023). The first, autonomy, allows AI-powered e-tutors to offer learners control over their learning paths by providing choices in how they engage with content, set goals, and pace their learning. Second, competence is reflected through personalised feedback and adaptive learning strategies; AI-powered e-tutors help learners build competence by addressing their learning gaps and challenging them appropriately. This tailored support enables learners to experience mastery and progression, boosting their confidence and motivation. Third, relatedness can be facilitated by creating interactive and engaging learning experiences. Features such as virtual peer collaboration, social learning components, and empathetic AI responses contribute to learners feeling connected and supported, which is crucial for maintaining motivation in self-directed learning (Marquardson, 2024; Lin, 2023). Below is the methodology that guided the review of existing literature from 2021 to 2024 on the role of AI-powered e-tutors in enhancing self-directed learning in ODeL courses.

3. Research Methodology

We extensively reviewed existing literature from 2021 to 2024 to explore the role of AI-powered e-tutors in enhancing self-directed learning in ODeL courses. This methodology section outlines four phases of the systematic review process, which are designing, conducting, analysing, and writing up the review. The process is informed by established guidelines and standards for literature review studies (Liberati et al., 2009; Tranfield et al., 2003; Wong et al., 2013).

3.1 Phase 1: Designing the review

We identified the need for this review by assessing existing literature on AI-powered e-tutors and self-directed learning (SDL) in open and distance e-learning (ODeL) courses. Our contribution lies in synthesising current knowledge and identifying gaps that warrant further research. The primary audience includes educators, researchers, policymakers, and technology developers interested in integrating AI into education and its impact on SDL. The specific purpose was to investigate how AI-powered e-tutors enhance self-directed learning in ODeL. Key research questions of significant interest and relevance include: What are the roles of AI-powered e-tutors in enhancing self-directed learning in open distance e-learning courses? Given the exploratory nature of the research questions, a narrative review approach was deemed appropriate. This method allows for a comprehensive synthesis of diverse studies and theoretical perspectives. Search terms included the following three keywords, which helped to unearth appropriate articles that guided data generation for this study: "AI-powered e-tutors," "self-directed learning," and "open distance e-learning," along with related keywords.

3.1.1 Search using systematic literature review methodology

This phase focused on perfecting the search strategy and delivering the expected combination from databases. The search string of words listed in Table 1 concentrated on "AI-powered e-learning," "Self-Directed Learning," and "Open Distance e-Learning." It was necessary to use additional syntax, specifically TITLE-ABS-KEY, to facilitate the search engine in generating the most appropriate outcomes, such as "Artificial Intelligence e-tutors to enhance student engagement and support," "Artificial Intelligence e-tutors in promoting adaptive feedback and support," "Artificial Intelligence e-tutors promoting student engagement and motivation," or "Artificial Intelligence enhancing academic performance." These search terms were run separately or, at times, in limited combinations consistent with the procedures or limitations of the databases used.

It was important to first attempt to download publications; however, when such publications were not available for this study, they were rejected immediately. Databases such as Scopus, Google Scholar, PubMed, ERIC, and IEEE Xplore were utilised to locate and extract three of the most relevant articles from each database, resulting in 15 peer-reviewed articles. Inclusion criteria included peer-reviewed articles restricted to publications published between 2021 and 2024 and studies conducted in English. The rationale behind targeting the year 2021 was that the Covid-19 pandemic forced many Open Distance e-Learning (ODeL) institutions of higher learning to transition their teaching to e-learning, while students began adopting a Self-Directed Learning approach. Furthermore, this period witnessed a major curriculum revolution and adaptation, which accelerated the development of AI and other related e-learning tools and Learning Management Systems (LMS) to support learning in ODeL institutions.

Thus, a cautious approach was adopted to ensure strict inclusion and exclusion criteria, which were necessitated by the need to narrow down the results to the most relevant articles to achieve the objectives of this study. In essence, all articles and studies that were non-peer-reviewed, older than five years, or published in a language other than English were automatically excluded.

3.1.2 Selection of relevant articles

This study made a conscious decision to address the question of inclusion and exclusion criteria by establishing clearly defined criteria for this phase. All articles that met the inclusion criteria were identified and selected for rigorous scrutiny based on their relevance and content assessment. To maintain a strict level of selection, the researchers excluded articles that were grey-listed, as well as extended abstracts, presentations, keynotes, review articles, and non-English language articles. All articles with these characteristics were excluded during the preliminary review, as they did not meet the minimum requirements and, therefore, their scope completely disqualified them from the review and selection process. Table 1 below presents the predefined literature inclusion and exclusion criteria followed to ensure strict control of the articles for this study.

Table 1: *Inclusion and exclusion criteria*

Criteria	Decision
When the predefined keywords exist as a whole or at least in the title. Keywords or abstract section of the paper.	Inclusion
Paper published in a scientific peer-reviewed journal	Inclusion
The paper should be written in the English language	Inclusion
Studies presented in pieces of evidence on AI-related fields	Inclusion
When the articles address at least one SDL indicator	Inclusion
Papers that are duplicated within the search documents	Exclusion
Papers that are not accessible, review papers and meta-data	Exclusion
Papers that are not primary/original research	Exclusion
Papers that got published before 2020	Exclusion

3.1.3 Quality assessment

It was critical that this systematic review adopts very strict quality assessment (QA) criteria in order to improve evaluation:

QA1: Are the review's inclusion and exclusion criteria described and appropriate?
QA2: Is the literature search likely to have covered all relevant studies on the topic?
QA3: Did the selection publication have blind reviewers that assess the quality/validity of the study?
QA4: Was the type of MES mentioned in the publication described adequately?

3.2 Phase 2: Conducting the review

A pilot test was conducted using the defined search terms and inclusion criteria. Adjustments were made based on initial results to ensure the search yielded a relevant sample. Articles were selected using a staged process: initial screening of titles and abstracts, followed by full-text review. The quality of the search process and selected articles was meticulously assessed using established quality appraisal tools tailored to the type of study (CASP checklists for qualitative studies).

3.3 Phase 3: Analysis

Information was abstracted to include author details, publication year, study design, key findings, and relevance to the research questions (see Table 2). Thematic analysis was employed to identify recurring themes and patterns related to the effectiveness of AI-powered e-tutors in promoting self-directed learning.

Table 2: Searching items used and the total number of publications from each database

Databases	Searching string and searching terms	No of articles	Date of acquisition

Scopus,	Main searching terms-using doc title, abstract, and keywords	"Artificial Intelligence e-tutors to enhance student engagement and support" "Self-Directed Learning" "Open Distance e-Learning Institutions"	3	26/10/2024
Google Scholar,	Main searching terms-using doc title, abstract, and keywords	"Artificial Intelligence e-tutors in promoting adaptive feedback and support" "Self-Directed Learning" "Open Distance e-Learning Institutions"	3	15/10/2024
PubMed,	Main searching terms-using doc title, abstract, and keywords	"Artificial Intelligence e-tutors promoting student engagement and motivation" "Self-Directed Learning" "Open Distance e-Learning Institutions"	3	20/10/2024
ERIC and	Main searching terms-using doc title, abstract, and keywords	"Artificial Intelligence enhancing academic performance" "Self-Directed Learning" "Open Distance e-Learning Institutions"	3	10/09/2024
IEEE Xplore	Main searching terms-using doc title, abstract, and keywords	"Artificial Intelligence enhancing academic performance" "Self-Directed Learning" "Open Distance e-Learning Institutions"	3	06/08/2024

3.4 Phase 4: Writing up the review

The introduction communicates the motivation for the review, highlighting the gap in the literature regarding AI-powered e-tutors and SDL in ODeL. The review adhered to PRISMA guidelines for systematic reviews and narrative synthesis standards for narrative reviews. It includes a detailed description of the methodology, a synthesis of findings, a discussion of implications, and an identification of gaps for future research. Findings are presented clearly, with themes and patterns identified through the analysis. The researchers took necessary steps to minimise bias during searching, identification, appraisal, synthesis, and analysis by using unambiguous and systematic procedures throughout the write-up and review. This phase was critical in ensuring that the procedures had minimal errors, enabling the study to provide reliable findings and conclusions that could help policymakers in higher education make informed decisions. The review's contribution to the field is explicitly communicated, emphasising its practical and theoretical implications, thus providing a comprehensive understanding of the role of AI-powered e-tutors in enhancing SDL in ODeL courses.

4. Findings

AI-powered e-tutors significantly enhance SDL in ODeL environments by providing a personalised learning experience, adaptive feedback and support, student engagement and motivation, and improved academic performance. They also foster engagement and facilitate continuous improvement. These critical issues emerged from four themes generated from each critical research question, and the findings are presented in that order. The first theme, concerning student

engagement and support, was developed to guide the first research question, which seeks to explore how AI-powered e-tutors enhance Self-Directed Learning (SDL) in Open Distance eLearning (ODeL) courses. The second theme, based on adaptive feedback and support, emerged from the second research question regarding the benefits and challenges of using AI-powered e-tutors to promote SDL. The third and fourth themes emerged from the third research question on how AI-powered e-tutors influence learner engagement, motivation, and academic performance in ODeL environments. These themes focus on student engagement, motivation, and the academic performance of ODeL students.

4.1 Theme 1: Personalised learning experiences

AI-powered e-tutors have significantly impacted personalised learning experiences by tailoring content and instructional strategies to cater to the unique needs of individual learners. AI-based tools have the potential to revolutionise higher education by promoting radical transformation in teaching and learning, including new teacher/student interfaces, such as chatbots and e-tutors, personalised learning paths, fast and individualised feedback, and instructional support (Tinterri et al., 2024). Intelligent tutoring systems (ITS) are one of the newest breakthroughs and a ground-breaking method for helping students achieve individualised learning experiences. Using AI and data analytics, these systems can customise instructional materials and approaches to meet each user's unique demands and learning style. ITS can significantly improve educational efficacy by offering dynamic and adaptable learning environments that address the individual needs of every learner (Bhushan et al., 2023). This customisation has increased student engagement and motivation, improving self-directed learning outcomes. In other words, AI-powered e-tutoring can create truly personalised learning experiences that cater to the unique needs of each student, enhancing their engagement, motivation, and overall educational outcomes. ITS enhances learning by providing tailored educational experiences that align with individual student requirements, competencies, and preferred learning methods, fostering more effective and engaged learning (Bhushan et al., 2023). AI tutors can assess students' strengths, weaknesses, and learning pace, creating customised learning paths. This ensures students are neither overwhelmed nor bored, maintaining their engagement and motivation. The results of the study by Robert (2024) concur with these findings, revealing that AI tutors can effectively develop personalised learning paths for students, leading to improved academic performance and increased engagement. AI e-tutors can adapt the learning material based on the student's progress, strengths, and weaknesses.

AI-powered educational platforms have the capability to analyse vast amounts of data to understand students' learning styles, preferences, and knowledge gaps (Khazanchi et al., 2021; Guan et al., 2020). With this information, AI can provide personalised learning experiences by delivering tailored content, resources, and assessments to each student (Maphalala et al., 2023; Murniati et al., 2023; Robert et al., 2023). Personalised learning allows students to progress at their own pace, focus on areas where they need improvement, and explore advanced concepts when ready. This individualised approach enhances student engagement, motivation, and overall learning outcomes (Letseka et al., 2018).

4.2 Theme 2: Adaptive feedback and support

The real-time feedback and support provided by AI-powered e-tutors are instrumental in helping students navigate complex subjects and assignments. For example, AI can provide individualised, immediate, and specific feedback that helps students understand their mistakes and learn more effectively. One example of AI-enabled personalised learning is the use of Intelligent Tutoring Systems (ITS). These advanced systems leverage AI algorithms to assess students' knowledge and skills, pinpoint any gaps in understanding, and provide tailored instruction and support. ITS can dynamically adjust the difficulty level, pace, and content based on the ability and progress of each student – a true testament to their adaptability, ensuring that every individual is appropriately

challenged while receiving necessary guidance (Rizvi, 2023). The use of AI to power gamified learning is quickly becoming a popular choice among educators. By providing real-time feedback and progress tracking, AI allows students to measure their growth and accomplishments in an organised way. Interactive visualisations, performance dashboards, and personalised improvement recommendations help cultivate a sense of self-awareness and efficacy, which are critical components for sustaining motivation (Rizvi, 2023).

The provision of immediate and constructive feedback takes priority in the new AI, enabling timely and constructive responses to students (Maphalala et al., 2023; Murniati et al., 2023). Automated grading systems powered by AI algorithms can assess assignments, quizzes, and exams quickly, providing students with immediate feedback on their performance (Robert et al., 2023). This prompt feedback allows students to understand their strengths and weaknesses, identify areas for improvement, and make necessary adjustments in real time.

4.3 Theme 3: Student engagement and motivation

AI-powered e-tutors have contributed to higher levels of learner engagement and motivation. Incorporating emotional and social engagement AI in education presents exciting opportunities for collaboration, interaction, and peer learning. Leveraging advanced algorithms to connect students with shared interests can help create a sense of community while promoting active participation among learners (Rizvi, 2023). Through virtual classrooms, online forums, and other platforms powered by AI-driven technologies, individuals can exchange ideas while developing essential social-emotional skills such as empathy and effective communication (Paek & Kim, 2021). The interactive and responsive nature of these systems keeps students more actively involved in their learning processes, which is crucial for maintaining momentum in ODeL environments. Intelligent Tutoring Systems (ITS) and virtual learning assistants can facilitate group discussions, provide guidance, and foster collaboration among students. These AI-powered tools can promote active participation, critical thinking, and problem-solving skills, creating a dynamic learning environment that mirrors real-world scenarios.

4.4 Theme 4: Academic performance

Integrating AI-powered e-tutors into ODeL courses has been associated with notable improvements in academic performance. E-tutors using AI approaches can benefit the educational sector in various contexts. Nguyen et al. (2023) cite examples of AI-assisted education, including innovative virtual learning, intelligent teaching, and data analysis and prediction. ITS provide timely, personalised training and feedback to both teachers and students. To increase the value and effectiveness of learning, they primarily use machine learning technologies (Perrotta & Selwyn, 2020), which are closely related to statistical models and cognitive learning theory. By providing consistent, personalised guidance and resources, these tutors have helped students achieve better results and a deeper understanding of course material, promoting successful SDL (Maphalala et al., 2023; Murniati et al., 2023). AI tutors are available around the clock, allowing students to learn freely without stress, as they can study at their own pace and according to their own schedules. Choosing their own time and pace enhances their academic performance. AI systems will, of course, greatly assist students, as they can customise the tutors according to their needs regarding pace, time, and space (Hemachandran et al., 2022).

AI in adaptive learning involves analysing students' learning patterns and developing a customised learning process that will help students achieve their best academic performance. Through this intelligent use of AI, tutors can identify students' strengths and weaknesses and then tailor their teaching strategies to meet individual needs and improve performance (Lin et al., 2023; Hemachandran et al., 2022). When considering adaptation and personalisation in tutoring systems, one of the ways AI is being employed in these personalisation systems is through adaptive learning.

Adaptive learning is a personalised approach to education that maximises each student's learning, subsequently recommending categories and guidelines (Paramythis & Loidl-Reisinger, 2003). This means that using AI in adaptive learning involves analysing students' learning patterns and developing a customised learning process that will assist students in achieving their best academic performance. Through this intelligent use of AI, tutors can identify students' strengths and weaknesses and tailor their teaching strategies to meet their needs (Lin et al., 2023; Maphalala et al., 2023; Murniati et al., 2023).

AI-powered e-tutoring platforms can accommodate students with diverse needs, including those with disabilities, by offering text-to-speech, customisable interfaces, and alternative input methods. Intelligent learning analytics enable advanced data analytics that can provide valuable insights into students' learning progress and patterns, as well as areas for improvement. By analysing data on student performance, AI algorithms can identify trends and patterns, allowing educators to make data-informed decisions (Robert et al., 2023; Bhushan et al., 2023). Intelligent learning analytics can help educators identify struggling students, personalise interventions, and develop targeted instructional strategies. This data-driven approach supports evidence-based teaching practices and enhances the overall effectiveness of educational interventions (Robert et al., 2023).

4.5 Theme 5: Challenges and limitations

Despite their benefits, implementing AI-powered e-tutors presents challenges and limitations, as highlighted by numerous scholars (Kin et al., 2023; Maphalala et al., 2023; Murniati et al., 2023). Issues such as unequal access to technology, concerns about data privacy, and the need for ongoing refinement of AI algorithms to ensure accuracy and fairness have been identified as significant hurdles that must be addressed to optimise the effectiveness of AI in education. Acknowledging these challenges, as demonstrated by Letseka et al. (2018) and Guan et al. (2020), is the first step towards finding solutions that ensure the responsible and equitable use of AI in education.

Bhushan et al. (2023) and Robert et al. (2023) note that integrating AI into education also poses challenges that must be addressed. Privacy concerns arise when dealing with student data, as AI relies on collecting and analysing personal information to provide personalised experiences. Establishing robust data protection measures and ensuring the ethical use of AI technologies to safeguard student privacy is vital (Guan et al., 2020; Letseka et al., 2018). Additionally, there is a risk of overreliance on AI, which could lead to a passive learning experience for students. While AI can provide personalised content and feedback, it is essential to balance AI-driven instruction with human interaction. Educators and policymakers must ensure that AI technologies complement and enhance human instruction rather than replace it entirely (Maphalala et al., 2023; Murniati et al., 2023; Robert et al., 2023). Robert et al. (2023) present several challenges and concerns associated with AI in education that need to be addressed:

- **Privacy and data security:** AI relies on collecting and analysing large amounts of student data to provide personalised learning experiences. This raises concerns about the privacy and security of student information. Safeguarding personal data and ensuring compliance with data protection regulations are crucial. Educational institutions and AI developers must establish robust security measures and protocols to protect student privacy and prevent unauthorised access to sensitive data.
- **Ethical considerations:** AI technologies in education raise ethical questions, particularly regarding the use of student data and the decision-making processes of AI algorithms. There is a need to ensure transparent and accountable AI systems that uphold ethical standards. Educators and policymakers must address issues related to bias, fairness and transparency in AI algorithms to ensure equitable access to educational opportunities for all students.
- **Overreliance on AI:** While AI can provide personalised learning experiences, there is a risk of overreliance on AI technologies, leading to a passive learning experience for students. It

is crucial to strike a balance between AI-driven instruction and human interaction. Human educators play a vital role in providing the guidance, support, and personalised instruction that AI alone cannot replicate. Maintaining a balance between AI and human instruction is essential for fostering meaningful learning experiences.

- **Access and equity**: The widespread adoption of AI in education raises concerns about access and equity. AI technologies require infrastructure such as computers, internet connectivity, and devices, which may not be available to all students, particularly those from disadvantaged backgrounds. Ensuring equitable access to AI-powered tools and resources is essential to prevent the exacerbation of existing educational inequalities.
- **Skill development and adaptability:** As AI technologies continue to evolve, there is a growing need for students and educators to develop the necessary skills to use and interact with AI systems effectively. Students must be equipped with critical thinking, problem-solving, and digital literacy skills to navigate the AI-driven educational landscape. Additionally, educators need professional development opportunities to learn how to integrate AI technologies effectively into their teaching practices.

5. Discussion of Findings

The findings of this study highlight the transformative impact of AI-powered e-tutors in ODeL environments. These technologies have reshaped the educational landscape by enhancing SDL, providing personalised learning experiences, delivering adaptive feedback and support, boosting student engagement and motivation, and improving academic performance. However, according to Maré and Mutezo (2021), these advancements come with challenges and limitations that require careful consideration by both teaching staff and e-tutors. The recruitment of highly skilled e-tutors who understand their role in promoting pedagogical, social, and technical competence cannot be overstated in enhancing the AI used in the ODeL environment.

AI-powered e-tutors have revolutionised personalised learning by tailoring content and instructional strategies to meet the unique needs of individual learners. This aligns with the principles of constructivist learning theory, which suggests that learners construct their understanding and knowledge of the world through experiences and reflection. Thampinathan (2022) reiterates that investment in technology, including AI, is critical for successfully implementing this learning theory, as the positive results outweigh the negatives. Students can directly benefit from the personalised AI-powered e-tutors and other online communities of practice and collaborative learning advocated by constructivist learning theory and SDT principles (Maré & Mutezo, 2021; Thampinathan, 2022).

The ability of AI-powered e-tutors to offer real-time, individualised feedback and support has been instrumental in helping students navigate complex subjects and assignments. This finding aligns with the work of Darvishi et al. (2024), which reveals that adopting AI-powered educational technologies has shown tremendous potential for leveraging AI as a personal assistant. Constructivist learning theory emphasises the importance of feedback in the learning process, as it allows students to reflect on their understanding and refine their knowledge structures. The immediate and specific feedback that AI provides ensures that students can promptly address their mistakes and misconceptions, thereby fostering a deeper understanding of the material. Moreover, this adaptive support aligns with SDT, highlighting the significance of autonomy, competence, and relatedness in enhancing motivation and learning.

AI-powered e-tutors have significantly contributed to higher learner engagement and motivation levels by incorporating emotional and social elements into the educational experience. The use of AI to facilitate collaboration, interaction, and peer learning—such as through group projects where AI can provide guidance and feedback, online discussions moderated by AI to ensure constructive participation, and peer review systems where AI can assist in providing fair and accurate evaluations—aligns with SDT's focus on relatedness, which refers to the need for individuals to feel

connected and involved with others. The introduction of AI-powered technology must accelerate learner motivation to engage with content and provide skills to critique existing epistemologies to improve the quality of teaching and learning (Darvishi et al., 2024).

Integrating AI-powered e-tutors into ODeL courses has been associated with notable improvements in academic performance. This improvement can be attributed to the personalised learning experiences, adaptive feedback, and increased engagement and motivation facilitated by AI. This aligns with constructivist learning theory and SDT, as the personalised and supportive learning environment promotes deeper understanding and intrinsic motivation, leading to better academic outcomes. Shah (2019) emphasises that institutions of learning must promote genuine learning that encourages students to be active, not passive. AI, with its ability to provide personalised learning experiences and adaptive feedback, is a powerful tool in this regard, inspiring active learning and the construction of students' own interpretations of the subject matter.

Despite the numerous benefits, implementing AI-powered e-tutors in ODeL environments presents several challenges and limitations. Issues such as unequal access to technology, concerns about data privacy, and the need for ongoing refinement of AI algorithms to ensure accuracy and fairness are significant hurdles that must be addressed. Unequal access to technology can exacerbate educational inequalities, while data privacy concerns may hinder the widespread adoption of AI in education. Furthermore, the accuracy and fairness of AI algorithms must be continually monitored and improved to prevent biases and ensure equitable learning opportunities for all students. In addition, the potential for overreliance on AI and the need for human intervention in certain learning situations are other challenges that need to be considered. The recent study by Darvishi et al. (2024) underscores the need to be vigilant about providing AI assistants with writing feedback, suggesting that students tend to rely on AI assistance but also actively learn from it. Addressing these challenges is not just important; it is urgent, as they can significantly influence the effectiveness and fairness of AI in education.

The integration of constructivist learning theory and Self-Determination Theory (SDT) provides a useful framework for understanding the impact of AI-powered e-tutors in Open and Distance e-Learning (ODeL) environments. Maré and Mutezo (2021) conclude that constructivist learning theory emphasises the active role of learners in constructing knowledge through experience, which is facilitated by the personalised and adaptive features of AI. SDT highlights the importance of autonomy, competence, and relatedness in fostering motivation and engagement, all of which are enhanced by the real-time feedback, emotional and social engagement, and collaborative opportunities provided by AI-powered e-tutors. This underscores the potential of AI not only to enhance learning outcomes but also to foster a sense of autonomy and competence in students, thereby shaping a more promising future for education.

6. Conclusion

The study reveals that students heavily rely on AI-powered e-tutors for writing their assignments, projects, and other academic activities. In essence, AI-powered e-tutors provide necessary support by anticipating learning paths, plugging knowledge gaps, and leading to improved academic performance and increased engagement. It is evident that AI-powered e-tutors offer significant advantages when it comes to feedback on assignments and other activities, helping students improve their learning and make necessary adjustments in real time. In line with constructivist learning theory, the proper recruitment of highly competent AI-powered e-tutors will strengthen the implementation of ODeL courses, creating highly qualified students who take pride in the independent skills they develop while completing their courses.

Students' and trainees' ability to use sophisticated technologies aligned with AI-powered e-tutors is indeed a product of an effective learning environment that is sensitive to the level of scaffolding and

adaptability required for inculcating new content knowledge. It is clear that AI-powered e-tutors assist students by providing personalised reminders for completing tasks and automated real-time feedback for improving writing, thereby enhancing the quality of their work. Elevating learner engagement with content learned through AI-powered e-tutors must take precedence, as it promotes motivation and social elements in the educational experience.

In this regard, it can be concluded that effective constructivist teaching should be flexible and attentive to the actual needs of the students. Students should continue to perform better even when AI-powered e-tutors are removed, and feedback of the same quality should be provided without the guidance of AI technology. The implication of this study is that reinforcing new innovations in the education sector must be encouraged and supported to better respond to current demands. The only limitation of this study is that the data set was confined to studies done elsewhere, with a focus on ODeL institutions where SDL is more evident and pronounced.

7. Declarations

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