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Integrating Artificial Intelligence in Open, Distance, and e-Learning (ODeL): A Systematic Literature Review

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Abstract
Artificial Intelligence (AI) is increasingly transforming Open, Distance, and e-Learning (ODeL) by enhancing personalization, automating assessments, and enabling immersive learning environments. This study employs a Systematic Literature Review (SLR) to explore AI's current role, applications, and challenges within ODeL from 2019 to 2024. Grounded in the Diffusion of Innovations Theory (DIT) and the Technology Acceptance Model (TAM), the study identifies key AI applications such as intelligent tutoring systems, predictive analytics, affective computing, and AI-driven virtual reality. Despite these advancements, AI adoption in ODeL remains limited due to ethical concerns, digital inequality, lack of empirical evidence, and insufficient faculty training. The study underscores the need for inclusive strategies, robust ethical frameworks, and professional development to support sustainable AI integration in ODeL environments.
Keywords: Artificial Intelligence, Open, Distance and e-Learning (ODeL), Systematic Literature Review, Technology Acceptance Model, Diffusion of Innovations Theory.

Introduction

Open, Distance, and e-Learning (ODeL) has increasingly become a vital component of modern education, offering flexible learning opportunities to students who are unable to participate in conventional, face-to-face learning environments. ODeL relies heavily on technological tools and digital platforms to deliver content, interact with learners, and assess performance, making education more accessible across geographical and socio-economic boundaries (Moore & Kearsley, 2012).

The integration of Artificial Intelligence (AI) into ODeL environments represents a significant advancement in educational technology. AI has the potential to transform how learning is designed, delivered, and experienced. It can support teachers in content development, provide intelligent tutoring systems, automate administrative tasks, and enable personalized learning experiences tailored to the needs and pace of individual learners (Luckin et al., 2016). AI-enabled Learning Management Systems (LMS) are capable of generating adaptive text, graphics, audio, and visual content, thereby enriching the educational experience and improving learning outcomes (Holmes et al., 2019).

Although AI has the potential to transform education, its adoption in ODeL systems remains limited, slow and fragmented. Several challenges have been identified such as outdated infrastructure, lack of faculty training, limited funding, and difficulties in integrating AI tools with existing curricula hinder its full implementation (Zawacki-Richter et al., 2019). At many institutions, ODeL has been embraced as a mode of instruction; however, the utilization of Artificial Intelligence to enhance its delivery is still in its early stages. This is especially evident in university courses that integrate both theoretical and practical components, such as Computer Science, Engineering, Nursing, Agriculture, and Education. These disciplines demand not only conceptual understanding but also hands-on practice, which can be facilitated through AI-driven tools like virtual labs, adaptive learning platforms, and intelligent tutoring systems (Zawacki-Richter et al., 2019; Holmes et al., 2019). AI technologies in such contexts offer

innovative ways to simulate real-world scenarios, assess practical skills, and provide personalized feedback to learners, thereby enriching the ODeL experience.

This study aims to analyze the role of Artificial Intelligence (AI) in shaping the future of Open, Distance, and e-Learning (ODeL), assess the nature of AI applications within this context, and explore emerging research challenges and opportunities for more effective integration, based on a systematic literature review.

THEORETICAL FRAMEWORK

1. Diffusion of Innovations Theory in the Context of AI Adoption in ODeL Institutions

The *Diffusion of Innovations Theory* (DIT), originally developed by Rogers (1995) and later expanded (Rogers et al., 2014), provides a valuable theoretical lens for analysing the adoption dynamics of Artificial Intelligence (AI) in Open, Distance, and e-Learning (ODeL) environments. DIT conceptualises innovation adoption as a socially embedded process influenced by communication patterns and interactions within a social system (Acikgoz et al., 2023; Rogers, 1995). In this study, DIT is employed to explore the factors shaping the integration of AI technologies among lecturers and students in ODeL institutions, with a focus on two critical dimensions: innovation characteristics and communication channels.

The dimension of innovation characteristics investigates users' perceptions of AI through five key attributes: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1995). These characteristics influence how AI tools are received and adopted by lecturers and students, particularly in terms of their perceived usefulness, alignment with existing pedagogical practices, ease of use, opportunities for experimentation, and visibility of positive outcomes (Dewi et al., 2023).

The second dimension, communication channels, highlights the pathways through which information about AI innovations is disseminated within ODeL institutions. These include both formal channels—such as institutional communications, training sessions, and academic conferences—and informal channels, including peer discussions, social networks, and collaborative communities (Acikgoz et al., 2023; Rogers et al., 2014). These communication avenues play a pivotal role in influencing awareness, attitudes, and ultimately the decision to adopt AI tools.

This study seeks to uncover adoption patterns, identify barriers, and understand the social mechanisms driving the diffusion of AI in digitally mediated learning environments. This approach contributes to a deeper understanding of how AI technologies are being embedded into teaching and learning processes, supporting the transformation and modernisation of open and distance education.

2. Technology Acceptance Model in the Context of AI in ODeL

This study applies the Technology Acceptance Model (TAM) to investigate the acceptance, perceptions, and integration of Artificial Intelligence (AI) among lecturers and students within Open, Distance, and e-Learning (ODeL) environments. Originally developed by Davis (1987), TAM offers a structured framework for exploring technology adoption through two principal constructs: Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) (Al-Adwan et al., 2023; Nnaji et al., 2023).

The PEOU construct examines educators' and learners' subjective assessments of how easily AI technologies can be incorporated into teaching and learning activities in ODeL settings. This includes considerations such as the user interface, accessibility, and the degree of effort required to effectively use AI tools (Balaman & Bas, 2023; Davis, 1987).

Meanwhile, the PU construct reflects the belief that AI contributes meaningfully to improving teaching methodologies, enriching student learning experiences, and transforming the instructional process (Davis, 1987; Lala, 2014; Nnaji et al., 2023). In particular, AI's ability to support academic writing through personalized feedback, automated assessment, and content generation is a focus of this study.

Using a qualitative research design, the study explores how lecturers and students perceive the usefulness and ease of use of AI tools in the development of academic writing skills (Balaman & Bas, 2023; Lala, 2014). This approach enables an in-depth understanding of the subjective factors influencing technology acceptance and adoption in a digital education environment.

Findings from this study aim to inform institutional strategies for AI integration, highlight areas requiring professional development, and guide the design of AI systems that align with the pedagogical goals of ODeL.

Methodology

This study employed a **Systematic Literature Review (SLR)** approach to gather, analyze, and This study employed a Systematic Literature Review (SLR) approach to collect, evaluate, and synthesize existing research on the integration of Artificial Intelligence (AI) in Open, Distance, and e-Learning (ODeL).

1. **Define Research Questions**: The review is guided by three main research questions about AI's role, applications, and challenges in ODeL.
2. **Literature Search & Collection**: A comprehensive search is done across various academic databases, focusing on peer-reviewed literature between 2019 and 2024.
3. **Inclusion & Exclusion Criteria**: Articles are filtered to include only those that are relevant to the study's focus, excluding non-peer-reviewed or unrelated material.
4. **Data Extraction & Categorization**: A standardized form is used to extract key data from each study, including publication details, AI technologies, educational context, and outcomes.
5. **Thematic Analysis & Synthesis**: The extracted data are analyzed thematically, looking for common patterns and emerging trends.
6. **Conclusion & Recommendations**: The synthesized findings are used to draw conclusions about AI's role and offer recommendations for further research and practice.

FINDINGS

1. The role of AI in shaping the future of ODeL and its current applications and use cases

Artificial Intelligence (AI) is revolutionizing Open and Distance e-Learning (ODeL) by enabling more adaptive, personalized, scalable, and inclusive educational experiences. Its integration supports not only content delivery but also the emotional, cognitive, and behavioral dimensions of learning.

1. Adaptive and Personalized Learning

a. AI technologies personalize learning pathways by analyzing real-time data, adjusting curricula, content delivery, and assessments based on learners' prior knowledge, pace, and style (Perifanis & Kitsios, 2023). Intelligent Tutoring Systems (ITSs), such as **Duolingo** (language tutors) and **Knewton** (adaptive learning), offer personalized instruction and feedback, addressing learning gaps (Dwivedi et al., 2021; Alam, 2021).

b. **Relevant Apps**:

- **Duolingo**: Language learning with adaptive lessons.
- **Knewton**: Adaptive learning platform that customizes content based on learner progress.
- **Cerego**: Spaced repetition and personalized review schedules for memory retention.

Table 1: **Technologies**, **Educational Context**, and **Outcomes**..

Publication Details	AI Technologies	Educational Context	Outcomes
1. **Perifanis & Kitsios (2023)**	Adaptive Learning, Intelligent Tutoring Systems (ITSs)	Open and Distance e-Learning (ODeL)	Personalized learning pathways, improvement in learning outcomes, better retention
2. **Dwivedi et al. (2021)**	Duolingo, Knewton	Language learning, Adaptive learning	Enhanced student engagement, better learning performance through personalized content
3. **Alam (2021)**	Knewton, Duolingo	Adaptive learning, Personalized education	Learners receive customized learning paths, with real-time feedback on progress
4. **Tsortanidou et al. (2022)**	Machine Learning, Predictive Analytics	Early intervention, ODeL environments	Improved student retention, early identification of at-risk students, personalized learning interventions
5. **Othman (2024)**	AI Robotics	STEM Education, Robotics in Education	Hands-on learning, engagement in STEM fields, enhancement of problem-solving and critical thinking skills
6. **Kurniawan et al. (2023)**	Robotics, AI	STEM education, experiential learning	Increased engagement in complex subjects, better understanding of engineering and technology concepts
7. **Odei-Tettey et al. (2023)**	AI Proctoring, Automated Assessment	ODeL environments, Academic Integrity	Enhanced assessment accuracy, reduced cheating, secure online exam environments
8. **Turnitin (2023)**	Turnitin, AI Proctoring	Academic Integrity, Online Testing	Prevention of plagiarism, enhanced fairness in assessments
9. **Klašnja-Milićević & Ivanović (2021)**	Computer Vision, Affective Computing	Emotional engagement in learning	Real-time feedback on learner emotions and cognitive load, better engagement and personalized emotional responses
10. **Yuvaraj et al. (2025)**	Affective Computing, Computer Vision	Emotional feedback, Learning Engagement	Improved learner engagement, emotional well-being, personalized emotional feedback
11. **Dwivedi et al. (2021)**	Accessibility AI Tools, Assistive Technology	Inclusive Education	Increased accessibility for learners with disabilities, equitable learning opportunities
12. **Radianti et al. (2020)**	Virtual Reality, Augmented Reality, AI	Immersive learning environments, ODeL	Increased learner engagement, immersive educational experiences, better contextual learning
13. **Xu & Babaian (2021)**	AI Virtual Assistants, Chatbots	Teacher Support, ODeL environments	Reduced educator workload, continuous support for students, increased efficiency in administrative tasks

Publication Details	AI Technologies	Educational Context	Outcomes
14. **Laupichler et al. (2022)**	AI Integration, Teacher Support Systems	Teacher-student interaction, Learning management systems	Enhanced teacher-student communication, more efficient use of AI tools in educational settings
15. **Sundar (2020)**	AI in Education, Human-AI Interaction	Pedagogical environments	Limited evidence of long-term AI effectiveness, concerns over reduced human interaction in learning
16. **Wang et al. (2022)**	AI, Machine Learning, Data Analytics	Digital Divide, AI Accessibility	Addressing the digital divide, improving access to AI-powered learning for underserved students
17. **Chen et al. (2022)**	Explainable AI (XAI), Algorithmic Fairness	AI Decision-Making, Educational Equity	Reduced bias in AI systems, better transparency and fairness in AI-driven educational decisions

2. Machine Learning (ML) and Predictive Analytics

a. **Machine Learning** algorithms analyze learner data, track knowledge acquisition, and predict academic performance. These models help identify patterns, predict dropout risks, and suggest personalized learning paths (Tsortanidou et al., 2022). **Predictive analytics** also provide early warnings of students at risk, improving retention and engagement through proactive interventions.

b. **Relevant Apps**:
- **Cerego**: Uses ML to predict retention and personalize learning materials.
- **Socrative**: AI-driven real-time student assessments, providing analytics and insights into performance.
- **IBM Watson Education**: Uses machine learning to offer personalized educational experiences and performance predictions.

3. Robotics in Education

a. AI-driven robotics in education uses intelligent robots to facilitate hands-on learning in subjects such as science, mathematics, and engineering. These robots can interact with students, provide practical demonstrations, and teach programming and robotics skills. By simulating real-world scenarios, they offer valuable experiential learning opportunities that enhance student engagement and understanding of complex concepts. Educational robotics fosters creativity, critical thinking, and problem-solving skills, preparing students for future careers in STEM fields (Othman, 2024; Kurniawan et al., 2023).

b. **Relevant Apps**:
- **LEGO Mindstorms**: A robotics kit that allows students to build and program robots, applying STEM concepts.
- **VEX Robotics**: Educational robotics platform that incorporates AI for learning programming and engineering.
- **Sphero Edu**: AI-powered robot that helps students learn coding and problem-solving skills through hands-on activities.

4. Automated Assessment and Academic Integrity

a. AI streamlines educational assessments by automating grading, detecting plagiarism, managing online proctoring, and applying biometric authentication techniques. These systems ensure academic integrity and enhance assessment reliability by leveraging real-time monitoring and advanced analytics. Tools like Turnitin and AI-powered proctoring platforms use machine learning and computer vision to detect anomalies, verify student identity, and ensure fair testing environments (Odei-Tettey et al., 2023; Turnitin, 2023).

b. **Relevant Apps**:
- **Turnitin**: Detects plagiarism and ensures academic integrity in written assignments.
- **ProctorU**: Provides remote proctoring with AI-based monitoring during online exams.
- **Grammarly**: Assists with academic integrity by helping students avoid unintentional plagiarism.

5. Computer Vision and Affective Computing

a. **Computer Vision** technology allows AI to analyze visual data, such as facial expressions, body movements, and engagement levels during online courses. This data can be used to assess student emotions and cognitive load, providing real-time feedback on learners' emotional states such as frustration or confusion (Klašnja-Milićević & Ivanović, 2021). **Affective Computing** refers to AI systems that use computer vision, speech analysis, and physiological sensor data to detect and respond to students' emotional states, such as frustration or engagement. By integrating these technologies into learning environments, affective computing supports personalized emotional feedback, enhances learner engagement, and promotes emotional intelligence in education (Yuvaraj et al., 2025).

b. **Relevant Apps**:
   - **Replika**: AI chatbot designed to provide emotional support and simulate empathetic conversations.
   - **Woebot**: Uses AI to provide mental health support by identifying emotional cues through text interactions.
   - **Affectiva**: AI-based emotion measurement tool that analyzes facial expressions to detect emotional responses in real-time.

6. Immersive and Inclusive Learning Environments

a. AI enables immersive learning through 3D virtual campuses, simulations, and gamified environments, providing real-world problem-solving experiences. AI-driven accessibility tools, such as text-to-speech, sign language interpreters, and assistive navigation, promote equity for learners with disabilities (Dwivedi et al., 2021). Robotics and virtual avatars can further enhance inclusivity by supporting physically disabled or neurodiverse learners in engaging with content in interactive ways.

b. **Relevant Apps**:
   - **Engage**: A platform for VR-based education, offering immersive learning environments and simulations.
   - **Microsoft Immersive Reader**: Text-to-speech tool that aids learners with reading difficulties.
   - **SignAll**: AI-powered sign language interpreter for learners with hearing impairments.
   - **Robobo**: A robot that can be used for both learning programming and offering physical interaction in inclusive educational settings.

7. Teacher Support and 24/7 Assistance

a. AI acts as a virtual teaching assistant, offering around-the-clock support via chatbots, FAQs, and automated responses to common queries, significantly reducing the workload of educators (Klašnja-Milićević & Ivanović, 2021). AI-powered systems also assist in administrative tasks like grading and personalized feedback, allowing teachers to focus on higher-level instructional planning.

b. **Relevant Apps**:
   - **Moodle with AI Plugins**: LMS that integrates AI to automate grading, notifications, and support functions.
   - **Edmodo**: Provides virtual classroom management and 24/7 student-teacher interaction via AI-driven tools.
   - **Ada**: AI chatbot that assists students with common questions and helps teachers manage student inquiries.

8. AI in Virtual Reality (VR) and Augmented Reality (AR)

a. AI-driven Virtual Reality (VR) and Augmented Reality (AR) technologies are increasingly used to create immersive, interactive environments in Open, Distance, and e-Learning (ODeL). These tools simulate real-world scenarios, enabling learners to engage in hands-on problem-solving, engineering tasks, and scientific experimentation. By incorporating AI, these environments dynamically adapt to a learner's performance and preferences, thereby enhancing engagement and ensuring that the learning experience is both personalized and contextually relevant. AI algorithms optimize content delivery, monitor user interaction, and adjust difficulty levels to improve learning outcomes (Radianti et al., 2020).

b. **Relevant Apps**:
   - **Oculus Education**: Uses VR to create immersive learning experiences in various disciplines, such as medicine, history, and science.
   - **ClassVR**: Provides an immersive learning experience using VR technology powered by AI to adapt to students' needs.

- **Google Expeditions**: An AR-based app that allows learners to explore 360° videos and virtual reality trips with AI support.

2. Challenges as Identified in the Literature Regarding AI Integration in ODeL

As Artificial Intelligence (AI) increasingly becomes part of Open and Distance e-Learning (ODeL) systems, numerous challenges have been identified in the literature. These challenges encompass ethical, structural, and pedagogical concerns that need to be addressed for successful AI integration in education.

1. Ethical Challenges in AI Integration in ODeL

One of the foremost concerns regarding AI integration in ODeL is the handling of sensitive learner data. AI systems depend heavily on large-scale data collection to tailor learning experiences and optimize instructional strategies. This raises critical ethical issues around privacy, data ownership, and informed consent (Paris et al., 2022; Rubinstein, 2013). To maintain user trust and institutional credibility, it is essential to implement transparent data governance frameworks, secure data storage practices, and adhere to privacy regulations such as the General Data Protection Regulation (GDPR) and the California Consumer Privacy Act (CCPA) (Kuzlu et al., 2021; Rothstein & Tovino, 2019).

2. Explainable AI (XAI) and Fairness Concerns

Incorporating Explainable AI (XAI) and ethical design principles such as Fairness, Accountability, and Transparency (FAT) is crucial for ensuring that AI-driven decisions in education are understandable, equitable, and justifiable. These frameworks help reduce algorithmic bias, which can perpetuate social inequalities if not addressed (Chen et al., 2022). Ethical challenges also arise from the use of proprietary Large Language Models (LLMs) and third-party AI platforms, especially regarding intellectual property rights, algorithmic opacity, and non-compliance with institutional data standards (Robinson, 2020).

3. Digital Divide and Access Inequality

The digital divide persists as a key issue, with noticeable disparities in access to reliable internet, digital devices, and AI-powered educational platforms—particularly in rural or underserved areas. These technological gaps disproportionately affect already disadvantaged learners, which can hinder the overarching goals of Open and Distance e-Learning (ODeL) by exacerbating educational inequality and limiting equitable access to AI-enhanced learning opportunities (Wang et al., 2022).

4. Lack of Empirical Evidence on AI Effectiveness

The lack of sufficient empirical evidence demonstrating the long-term effectiveness of AI in improving educational outcomes. Although pilot projects often show promise, large-scale, longitudinal studies have yet to conclusively prove significant improvements in student learning, engagement, or retention directly attributable to AI technologies (Sundar, 2020). Additionally, the human element in education, such as mentorship, emotional support, and interpersonal interaction, often gets sidelined when AI systems assume instructional roles, potentially leading to a more transactional, rather than relational, learning experience (Sundar, 2020).

5. AI Literacy and Skill Gaps in Education

A key barrier to the effective integration of AI in ODeL is the lack of AI literacy among educators and administrators. Many educators report feeling unprepared to use AI tools or interpret their outputs, which impedes the successful implementation of AI-driven instruction (Xu & Babaian, 2021). Furthermore, there is a significant shortage of skilled personnel capable of designing, deploying, and managing AI systems tailored to the educational context (Laupichler et al., 2022). This skills gap affects both system implementation and the ability of institutions to critically assess AI tools to ensure they align with pedagogical goals.

6. Resistance to Change and Financial Barriers

In addition to technical and skill-related challenges, resistance to technological change, organizational inertia, and limited financial resources present substantial hurdles to AI adoption in ODeL. Institutions often face difficulties in balancing the costs of upgrading infrastructure, training staff, and acquiring software with the uncertain returns on investment. To overcome these barriers, strategic planning,

interdisciplinary collaboration, and participatory policy development that involve educators, technologists, and learners are essential for responsible AI integration (Xu & Babaian, 2021; Laupichler et al., 2022).

Conclusion and Recommendations

AI is reshaping Open and Distance e-Learning (ODeL) by enabling personalized learning, predictive analytics, and immersive educational experiences, with platforms like Duolingo, Knewton, and IBM Watson Education enhancing learner engagement and outcomes. However, significant challenges remain, including ethical concerns around data privacy, the digital divide restricting access to technology, and the lack of AI literacy among educators. For successful integration, it is crucial to establish transparent ethical guidelines, bridge access gaps, invest in educator training, and conduct robust research to evaluate AI's long-term effectiveness. Addressing financial and organizational resistance will also be essential in fully realizing AI's potential in education.research to assess long-term effectiveness. Overcoming financial and cultural resistance will also be key to fostering widespread adoption and maximizing the potential of AI in education.

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