



Enabling Education Everywhere: How artificial intelligence empowers ubiquitous and lifelong learning

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Abstract

This article explores the complex interplay between Artificial Intelligence (AI), ubiquitous learning, and lifelong learning. Drawing upon in-depth analysis of pertinent literature, it elucidates the ways in which AI can bolster ubiquitous and lifelong learning in terms of personalized learning, continuous accessibility, adaptive content delivery, instant feedback and assessment, Natural Language Processing, data-driven insights, assistance and support, personal learning assistants, tailored learning resources and efficient time management. It also highlights the pre-requisite of harnessing AI for the purpose of ubiquitous learning, and lifelong learning. In the future, AI is anticipated to become the cornerstone of education systems across all levels.

Keywords: Artificial Intelligence (AI), ubiquitous learning, lifelong learning

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1.0 Introduction

Education has undergone a series of transformative phases, each propelled by the ever-evolving landscape of technology. Information Technology, in particular, has brought about significant changes in the way we approach learning (Haleem et al., 2022). The advent of smart classrooms marked a profound turning point, harnessing the power of technology to augment traditional teaching methods (Singh and Miah, 2020). Concurrently, the Internet emerged as a catalyst, enabling the concept of ubiquitous learning, wherein education transcends physical boundaries and becomes reachable from any corner of the world (Aljawarneh, 2020).

However, the evolution of education does not end here. The emergence of Artificial Intelligence (AI) has ushered in an era where the concept of the smart classroom has evolved into something even more outstanding: smart everywhere (Chen et al., 2020). With AI's remarkable capabilities, learning experiences are no longer limited to specific spaces or times. Instead, they permeate every facet of our lives, impeccably integrating with our daily routines and surroundings (Leung et al., 2023). This transformative synergy of AI and education is reshaping the educational landscape, boosting us into an era where learning is not just a classroom endeavour but a constant, dynamic, and personalized journey that accompanies us wherever we go.

1.1 Research Objectives

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This paper aims to explore the intricate interplay between Artificial Intelligence (AI) and the realms of ubiquitous learning and lifelong education. By unraveling the multifaceted ways in which AI synergizes with these domains, our objective is to traverse through the transformative potential that AI holds in shaping the future of learning. From seamless integration into ubiquitous learning environments to fostering a culture of continuous knowledge acquisition, we aim to explore how AI becomes the cornerstone of support, enriching the fabric of both ubiquitous learning experiences and the journey of lifelong education.

2.0 Literature Review

Artificial Intelligence (AI) refers to the field of computer science and technology that focuses on creating machines and systems that can execute tasks that typically require human intelligence (Wang, 2019). These tasks include problem-solving, learning from experience, reasoning, understanding natural language, and pattern recognition. AI aims to develop computers and software that can imitate cognitive functions, enabling them to make decisions, solve complex problems, and adapt to new situations without explicit human programming (Liu et al., 2022). It consists of various techniques, including machine learning, neural networks, natural language processing, and computer vision, to build systems that can process data, learn from it, and make informed decisions or predictions (Liu et al., 2022). Within the realm of education, AI emerges as an influential ally, wielding its capabilities to orchestrate a profound evolution in conventional teaching methods. Its canvas of impact spans the introduction of personalized learning experience, predictive analyses to anticipate learning trends, and the seamless automation of administrative duties, infusing the educational landscape with a dynamic synthesis of innovation and streamlined efficiency (Huang et al., 2021). Driven by an analytical prowess capable of unraveling intricate datasets, AI adeptly uncovers hidden patterns, tailors learning materials to diverse preferences, and augments the potency of educational workflows, ushering in an era of pedagogical transformation. A popular example of AI widely used by the general public is the virtual voice assistant, such as Amazon's Alexa, Apple's Siri, or Google Assistant. These AI-powered companions adeptly understand natural language, respond to queries, and execute tasks ranging from setting reminders and answering questions to controlling smart home devices. They have been easily integrated into households, making daily life more convenient by swiftly fetching information, managing schedules, and executing tasks, demonstrating the potential of AI to enhance everyday experiences.

Ubiquitous Learning relates to an educational paradigm that harnesses technology to create a seamless and continuous learning experience across various contexts, locations, and devices (Cárdenas-Robledo and Peña-Ayala, 2018). It transcends the confines of traditional classroom settings, allowing learners to access educational content, resources, and interactions at their convenience, breaking down barriers of time and space. Ubiquitous learning recognizes that learning is no longer confined to formal education institutions but can occur organically in everyday life through the integration of technology. This approach to learning is fuelled by the pervasiveness of digital devices, the Internet, and smart technologies. Ubiquitous learning blurs the distinction between formal and informal learning settings, enabling individuals to engage with educational materials during daily commutes, work breaks, or leisure time. It leverages technologies such as mobile apps, online platforms, artificial intelligence, and augmented reality to create a dynamic learning environment that corresponds to modern lifestyles. One of the significant merits of ubiquitous learning is its flexibility. Learners can access a wealth of educational resources, ranging from e-books and instructional videos to interactive simulations and quizzes, available at any time and from any location. This accommodates diverse learning preferences and enables individuals to take charge of their own learning journeys. Ubiquitous learning also flourishes on personalization. Advanced algorithms analyze learner data to adapt content and learning experiences according to individual needs, preferences, and progress. This personalized approach enriches engagement and motivation, fostering more effective learning outcomes. As an illustrative example, Amazon's Alexa, Apple's Siri, and Google Assistant can be employed for ubiquitous learning. These virtual voice assistants are readily available on smart devices and can serve as learning companions. Learners can ask questions, seek clarifications, and access educational content simply by speaking voice commands. For instance, learners can ask Alexa to define a specific term, request Siri to explain a complicated concept, or have Google Assistant recommend relevant study materials.

Lifelong Learning relates to the continual pursuit of knowledge, skills, and personal development throughout an individual's entire life (Sangrà, Raffaghelli and Veletsianos, 2019). It transcends beyond the traditional boundaries of formal education and encompasses diverse learning opportunities that contribute to personal growth, career enhancement, and overall well-being. Lifelong learning acknowledges that learning is a lifelong journey, emphasizing the importance of adaptability, curiosity, and an ongoing commitment to self-improvement.

The relationship between lifelong learning and ubiquitous learning is closely related (Shuguang et al. 2021). Ubiquitous learning serves as an enabler for lifelong learning by providing the tools and resources necessary for individuals to immerse in continuous learning throughout their lives. The flexibility and accessibility offered by ubiquitous learning platforms align closely with the concept of lifelong learning, allowing individuals to learn at their own pace and in diverse settings. For instance, lifelong learners can leverage ubiquitous learning technologies such as mobile apps, online courses, and virtual reality experiences to pursue learning opportunities anytime and anywhere (Mohtar et al. 2023). They can access educational content, collaborate in discussions, engage with peers, and even receive personalized feedback through these platforms. Ubiquitous learning extends the reach of lifelong learning by making it possible for individuals to engage in learning activities during their daily commutes, work breaks, or leisure time.

3.0 Research Methodology

This study utilizes a literature review as its research methodology. According to Paul and Criado (2020) a literature review article provides a thorough overview of relevant literature, synthesizing previous studies to strengthen the foundational knowledge. In recent years,

review articles have gained prominence and developed distinct rules and conventions, according to Patriotta (2020) The review process, as outlined by Patriotta (2020) involves scholars consuming existing work and using it as a springboard to generate new knowledge. This study aligns with Patriotta's (2020) suggested review process.

4.0 Findings

4.1 How AI Support Ubiquitous Learning

Artificial Intelligence (AI) stands as a pillar of support in the realm of ubiquitous learning, where education transcends beyond the confines of traditional classrooms to encompass diverse contexts and moments of life. By utilizing AI technologies, ubiquitous learning becomes an enriched, accessible, and adaptable experience for learners worldwide. Here's how AI supports ubiquitous learning (Delgado et al, 2020; Gao, Pi and Liu, 2021; Mekni, 2021; Srivastava et al. 2021; Furini et al., 2022; Chiu et al. 2022; Idroes et al. 2023):

- **Personalized Learning:** AI examines the preferences, learning styles, and previous encounters with content of learners. This data-driven insight enables AI to curate personalized learning pathways, delivering content that resonates with individual needs, preferences, and paces.
- **Continuous Accessibility:** Ubiquitous learning thrives on accessibility, and AI ensures that learners can access educational resources and support at any time and from any location. AI-driven content delivery is available whenever learners need knowledge, whether through mobile devices, wearables, or even voice assistants.
- **Adaptive Content Delivery:** AI monitors learners' progress and adapts content as needed. If a learner is having difficulty understanding a concept, AI can provide further explanations or supplementary activities. If, on the other hand, a learner exhibits mastery, AI can present more sophisticated content, creating a flow that corresponds to individual advancement.
- **Instant Feedback and Assessment:** Artificial intelligence-powered assessments deliver real-time feedback on assignments and quizzes. Learners receive immediate feedback on their performance, assisting them in finding areas for development and allowing them to quickly change their learning tactics.
- **Natural Language Processing (NLP):** Conversational connection between learners and content is facilitated by AI with NLP skills. Because learners may ask questions, seek answers, and access material in natural ways, this involvement promotes intuitive and responsive learning experiences.
- **Data-Driven Insights:** Data created by learners' interactions with information is analyzed by AI, providing patterns and insights regarding learning behaviors. Educators can use this data to improve teaching tactics, adjust curriculum, and address specific issues that students have.
- **Assistance and Support:** Chatbots and virtual assistants powered by AI provide on-demand assistance, guiding learners through issues and obstacles in real time. This assistance improves the learning experience by reducing frustrations and guaranteeing smooth development.
- **Personal Learning Assistants:** AI-powered technologies can serve as virtual instructors, offering advice, recommending resources, and even stimulating dialogues among students, promoting collaborative learning.
- **Tailored Learning Resources:** AI finds gaps in comprehension and recommends further resources, allowing students to explore deeper into subjects that interest them or address areas where they need to improve.
- **Efficient Time Management:** AI assists learners in successfully managing their time by recommending study schedules, breaks, and productive learning moments, hence optimizing learning outcomes.

Consider the case of a librarian who benefits from AI-powered assistance in omnipresent learning. Meet Syifa, a librarian who is committed to keeping up with the ever-changing environment of information management and digital resources. Despite her library obligations, Syifa wants continual study to improve her skills and provide greater service to users. Here's how artificial intelligence can help her on her journey (Table 1):

Table 1: Scenario of Professional Growth for a Librarian

AI Support	Scenario
Personalized Learning	Syifa enrolls in an online information technology and library sciences course using an AI-powered platform. The platform evaluates her current knowledge and preferences before customising the course content to her learning needs and pace.
Continuous Accessibility	Syifa, who is juggling library tasks, can access course materials and assignments via a mobile app, allowing her to learn during her breaks or beyond library hours.
Adaptive Content Delivery	The AI recognises Syifa's difficulties learning some sophisticated database administration concepts as she moves through the training. The platform replies by providing more video courses and case studies to help her understand the content better.
Instant Feedback and Assessment	Following the completion of assignments and quizzes, AI-powered tools provide immediate feedback on her responses. This instant feedback assists Syifa in identifying any misconceptions or areas for progress, allowing her to fine-tune her knowledge.
Natural Language Processing (NLP)	Syifa may ask natural language queries and receive exact answers that elucidate complex topics such as information retrieval and digital archiving.
Data-Driven Insights	As Syifa participates in the platform's chats and quizzes, the AI analyses her interactions and determines where she succeeds and where she needs more help. This data-driven methodology guides her research strategy.
Assistance and Support	When Syifa has difficulty grasping metadata standards, she consults with a virtual assistant who provides extensive explanations and links to pertinent resources.
Personal Learning Assistants	Syifa is connected to a community of colleagues librarians who share her commitment to professional development through the platform. They share ideas, best practises, and work together on practical projects.

Tailored Learning Resources	Recognising Syifa's interest in digitalization approaches, the platform suggests related resources such as webinars, research articles, and case studies.
Efficient Time Management	The software analyses Syifa's study habits and recommends a study timetable that maximises her available time while ensuring she maintains a balance between her library responsibilities and studying.

(Source: Author's Own Table)

In this real-world context, AI's support empowers Syifa, a librarian, to thrive in her professional growth journey. The adaptable and personalized platform ensures that her learning aligns with her unique needs, while immediate feedback, insights, and community engagement enhance her learning experience. Syifa's story underscores how AI integration in ubiquitous learning can elevate professionals like librarians in their pursuit of ongoing education and career development.

4.2 How AI Support Lifelong Learning

Incorporating AI support into the framework of lifelong learning improves all aspects, making the journey easier, more personalized, and more sustainable throughout the course of an individual's lifetime. Lifelong learners can pursue their educational goals while juggling the pressures of employment, family, and other duties by incorporating AI capabilities. Let's look at how each of the ten AI support elements in ubiquitous learning links to and enriches the concept of lifelong learning (Poquet and De Laat, 2021; Carvalho et al., 2022).

- **Personalized Learning:** AI's personalized approach to lifelong learning means that individuals can continue their education at any stage of life. Whether a person is retiring and learning a new skill or growing in their profession, AI tailors content to their present knowledge and learning preferences.
- **Continuous Accessibility:** The ability to access educational resources at any time and from any location becomes even more important for lifelong learners. AI guarantees that learners may engage with content on their own time, allowing them to balance their busy lives and different responsibilities.
- **Adaptive Content Delivery:** Individuals with diverse degrees of experience and ambitions pursue lifelong learning. AI modifies content delivery to account for these variances, guaranteeing that learners can progress from fundamental concepts to more advanced topics while remaining on track with their ongoing development.
- **Instant Feedback and Assessment:** Lifelong learners strive to always grow. This journey is aided by AI's quick feedback, which provides instantaneous insights into progress, assists learners in identifying areas for improvement, and guides their continued attempts to improve their skills.
- **Data-Driven Insights:** AI data analysis provides significant insights into lifelong learners' increasing strengths and areas that require attention. This data helps decisions about where to focus efforts and how to proceed.
- **Natural Language Processing (NLP):** As they interact with complicated subjects, lifelong learners frequently have particular inquiries. In their pursuit of continual learning, learners can use AI's NLP capabilities to seek clarification, go deeper, and explore nuances.
- **Assistance and Support:** Learners face obstacles and questions throughout their lives. AI's assistance in the form of virtual assistants and chatbots becomes a lifelong companion, helping students through problems and providing solutions at any point of their educational path.
- **Personal Learning Assistants:** AI-powered personal assistants become even more beneficial in the setting of lifelong learning. These assistants support learners in staying organized, recommending relevant resources, and connecting with communities of like-minded people.
- **Tailored Learning Resources:** Lifelong learners frequently have certain objectives in mind. The ability of AI to offer personalized resources ensures that people can pursue their interests and fill knowledge gaps as they navigate varied subjects throughout time.
- **Efficient Time Management:** Time is a valuable resource for people who are involved in lifelong learning. The function of AI in optimizing study plans and giving time management recommendations assists students in balancing their continuous education with other commitments.

5.0 Discussion

Unleashing AI's ability to drive ubiquitous and lifelong learning involves a thorough assessment of a number of important prerequisites, each of which plays a critical role in orchestrating a successful integration and generating powerful results. When these critical factors are intelligently handled, they create the foundation of a strategy that not only allows for the smooth integration of AI-powered educational solutions, but also plots a path towards a revolutionary learning experience distinguished by creativity, adaptability, and long-term value. These fundamental imperatives create a nexus where AI's capabilities coexist harmoniously with the goals of ubiquitous learning and lifelong development, resulting in a dynamic interplay that transcends traditional boundaries and propels learners on a purposeful journey of continuous knowledge acquisition and personal advancement. The prerequisites for using AI for ubiquitous and lifelong learning are highlighted below (Renz and Hilbig, 2020; Algabri et al., 2021; Khlaisang and Yoshida, 2022; Awan 2022; Nguyen et al. 2023):

- **Infrastructure and Technology:** A solid technology basis is required to ensure that learners may easily access AI-powered learning resources. This includes access to devices such as smartphones, tablets, and desktops, as well as compatibility with multiple operating systems and browsers.

- **Data Privacy and Security:** The security of learner data is critical. Organisations must use strong data encryption, secure authentication techniques, and adhere to relevant data protection rules (for example, GDPR). Users should be informed about transparent data usage regulations.
- **Digital Literacy:** Learners, educators, and stakeholders must have fundamental digital literacy skills in order to fully benefit from AI-enhanced learning. They should be able to navigate internet platforms, use digital tools, and comprehend AI-generated insights.
- **Content Diversity and Quality:** AI should aid in the curation and creation of diverse, high-quality learning resources. This contains text, videos, interactive simulations, and exams in a variety of media. Maintaining the legitimacy of the learning experience requires ensuring the quality of the information.
- **Educator Training:** Educators must be trained to use AI tools successfully, analyse data-driven insights, and provide assistance to students. This training helps them adapt their teaching methods to AI-enhanced surroundings.
- **Curriculum Alignment:** AI-powered learning content should be consistent with educational goals and curricular requirements. This guarantees that learning experiences are consistent and relevant to academic objectives.
- **Ethical Considerations:** It is critical to use AI ethically. Bias, discrimination, and transparency must all be addressed by developers and educators. They must ensure that AI systems do not exacerbate current inequities and are equitable to all learners.
- **Continuous Monitoring and Evaluation:** Monitoring learners' development and the usefulness of AI technologies on a regular basis aids in identifying areas for improvement. It allows teachers to make data-driven judgements about teaching tactics.
- **User Experience Design:** User-friendly interfaces and straightforward navigation should be prioritized in AI-enhanced platforms. Creating interesting interfaces encourages active learner participation and good experiences.
- **Customization and Personalization:** Learners should be able to customize their learning experiences with AI-powered technologies. Individual needs are met through personalized learning routes and flexible content.
- **Collaboration and Communication:** AI platforms should make it easier for learners, educators, and peers to communicate and collaborate. Discussion forums, chat, and group projects help to facilitate interactive learning experiences.
- **Technical Support:** A responsive technical support system assists learners and educators in quickly resolving technical challenges, providing continuous access to learning resources.
- **Accessibility:** AI systems should be created with accessibility in mind, allowing learners with disabilities to participate. This involves offering content in various formats, compatibility with screen readers, and adaptive interfaces.
- **Cost Considerations:** While AI has numerous advantages, institutions must consider the costs of creating, deploying, and maintaining AI-powered systems. A low-cost method ensures long-term acceptance.
- **Continuous Improvement:** AI systems must be able to adapt to changes and advancements. Regular updates based on user feedback and improvements in AI technology help to ensure continuous improvement.

By carefully addressing the details of each prerequisite, educational stakeholders may build the groundwork for the successful integration of AI into ubiquitous and lifelong learning, thereby improving the educational experience for both learners and educators.

6.0 Conclusions

This paper has shed light on the complicated and revolutionary relationship that exists within the sphere of education between AI, ubiquitous learning, and lifelong learning. AI's key characteristics, such as personalized learning, adaptable content delivery, and real-time feedback, indicate the technology's potential to revolutionize education by supporting individual growth and adaptability. Furthermore, the discussion on AI prerequisites emphasizes the need of laying a solid foundation for effective integration. Addressing issues like infrastructure, data protection, and educator training are critical to realizing AI's full potential. This all-encompassing strategy ensures that AI-assisted learning stays inclusive, effective, and consistent with the ideas of ubiquitous and lifelong learning.

As we gaze into the future, the harmonious convergence of Artificial Intelligence (AI), ubiquitous learning, and lifelong learning illuminates a promising path toward a dynamic and adaptive educational landscape. This synergy not only holds the potential to reshape the way we approach education but also to empower learners of diverse backgrounds and ages with personalized and continuous learning experiences. AI serves as the driving force behind this transformation, offering a catalyst for innovation. In this exciting paradigm, educators, learners, and institutions join forces to forge an educational ecosystem that is not only responsive but also perpetually innovative. Through the embracement of these transformative possibilities, they lay the foundation for nurturing lifelong learners who thrive in an ever-changing world. This collaborative effort ushers in an era where education transcends traditional boundaries and becomes a lifelong journey of exploration and growth, adapting seamlessly to the evolving needs and aspirations of individuals.

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