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Investigating the Role of Artificial Intelligence in Lifelong Learning for Information Technology Students at a University of Technology

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ABSTRACT

This theoretical paper examines the role of artificial intelligence as a tool for supporting the lifelong learning of students in Internet Technologies. With the advancement of artificial intelligence technology, education can be transformed through customized and flexible active learning. However, integrating artificial intelligence into Internet Technologies is a challenge, including coping with rapid technological change, lack of proper infrastructure, addressing the issues of varied learning, securing data privacy, and integrating artificial intelligence with existing educational frameworks. To do these things, the paper employed Activity Theory as a lens to explore the possibilities of AI as a learning mediator in social, cultural and historical settings, where communities and societies have a relation and attachment to learning. As a framework, Activity Theory was used to understand the relationship among students, artificial intelligence applications and their learning contexts, and how they affect students' participation and level of learning. This study is based on secondary data to investigate the role of artificial intelligence in lifelong learning for Information Technology students. Literature was sought from different databases, including Google Scholar, Web of Science, and Scopus. The study stresses the importance of adapting artificial intelligence applications to different educational settings to maximize their effectiveness. It highlights that, when thoughtfully integrated, artificial intelligence can significantly enhance lifelong learning for Internet Technologies students, who must continually adapt to rapidly changing technological advancements. The argument premised in this paper is that artificial intelligence used in internet technologies has the potential to promote lifelong learning among university students.

Keywords: *Artificial Intelligence, Internet Technologies, Activity Theory, Lifelong Learning, Information Technology*

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INTRODUCTION

Artificial Intelligence (AI) is gaining recognition as a powerful tool in reshaping lifelong learning, particularly in Information Technology (IT) education.[1] This paper investigates the role of AI in supporting and enhancing the lifelong learning experiences of IT students. In the IT industry, where technological advancements occur rapidly, ongoing rethinking of education is indispensable to align

[1] Wayne Holmes, Maya Bialik, and Charles Fadel, *Artificial Intelligence in Education Promises and Implications for Teaching and Learning* (Center for Curriculum Redesign, 2019); Rosemary Luckin, *Machine Learning and Human Intelligence. The Future of Education for the 21st Century* (UCL institute of education press, 2018).

Universities or higher institutions of learning and prepare the students accordingly. The implication of the foregoing is that professionals in this field must constantly enhance their knowledge and abilities to stay relevant in the competitive job market. The concept of lifelong learning, which emphasizes the continuous pursuit of knowledge and skills throughout one's career, is identified for IT professionals to stay competitive and adapt to new technologies. AI has emerged as a revolutionary tool that allows students to receive customized learning experiences, real-time feedback, and flexible learning paths based on their specific needs.

This study aims to investigate the role of AI in supporting lifelong learning for IT students. Incorporating AI into educational frameworks can enable IT students to learn more effectively and remain up to date with industry advances since they will be able to learn new skills more effectively. The use of AI brings with it many promises, but there are also challenges, such as privacy concerns, ethical issues, and the need for human oversight. It is these challenges that can threaten the use of AI; thus, research must continue to probe various ways to address the problem to ensure that AI serves humanity rather than its destruction.

The topic of AI and lifelong learning for IT students is still developing. The lack of emphasis on lifelong learning itself is an obvious gap. According to Gedrimiene *et al.*, the potential of AI to facilitate learning outside formal educational frameworks, such as primary, secondary, and tertiary education, remains significantly underexplored in comparison to its applications within these traditional settings.[2] The swift progression of technological innovations poses substantial challenges for students specializing in Internet Technologies, as it necessitates continuous enhancement of competencies throughout their careers.[3] Despite this necessity, there isn't a thorough examination in the literature regarding the ways in which AI can be tailored to meet the requirements of lifelong learning within the IT industry.

Internet technologies are developing at a rate that has never been seen before; thus, for students to be competitive in the digital world, they must always be learning new things.[4] However, because they are not designed for continuous, flexible learning, traditional educational models frequently fail to meet the unique needs of students enrolled in Internet technology courses. As a result, the fast-evolving technological abilities required in the industry diverge from what students acquire in formal education.
AI, especially Internet technologies, offers promising solutions for promoting lifelong learning. AI-driven solutions can provide personalized learning experiences, immediate feedback, and adaptive instructional content that changes with the times.[5] Although it has promise, using AI to enhance lifetime learning for Internet Technologies students remains under-researched.

The aim of this research project is to investigate how AI may be helpful for students studying Internet technologies by assisting them to learn more throughout their lives. In order to tackle the distinctive challenges that these students face in staying abreast of advancements within the industry and ensuring their readiness for achievement in a swiftly transforming digital landscape, the objective is to examine the potential applications of artificial intelligence in reconciling the disparity between formal educational frameworks and ongoing skills enhancement. In the following section, the study's theory is discussed.

In this paper, the opportunities and challenges associated with integrating AI into lifelong learning for Internet technology students were examined. This study contributes to a deeper understanding of how artificial intelligence can be used to support lifelong learning in an ever-changing technological environment and drive innovation, empowering students to adapt in a technologically changing world. The following section is critical to contextualize readers on the module in focus for this paper in relation to the challenges and opportunities for integrating AI.

The remainder of the paper is structured as follows: Section 2 introduces the philosophy that underpins this work, followed by a discussion of lifelong learning, Internet technologies, and information

[2] Egle Gedrimiene et al., "Artificial Intelligence (AI)-Enhanced Learning Analytics (LA) for Supporting Career Decisions: Advantages and Challenges from User Perspective," *Education and Information Technologies* 29, no. 1 (2024): 297–322.

[3] Win Phyu Thwe and Aniko Kalman, "Lifelong Learning in the Educational Setting: A Systematic Literature Review," *The Asia-Pacific Education Researcher* 33, no. 2 (2024): 407–17.

[4] Oleksandra Poquet and Maarten De Laat, "Developing Capabilities: Lifelong Learning in the Age of AI," *British Journal of Educational Technology* 52, no. 4 (2021): 1695–1708.

[5] Jiahui Huang, Salmiza Saleh, and Yufei Liu, "A Review on Artificial Intelligence in Education," *Academic Journal of Interdisciplinary Studies* 10, no. 3 (2021).

technology in Section 3. Section 4 discusses the current state of Artificial Intelligence in the Internet Technologies module. Types of Internet-based education using Artificial Intelligence are discussed in Section 5, followed by a discussion of Artificial Intelligence in Lifelong Learning in Section 6. The gaps in the literature are presented in section 7 and finally, the findings and conclusions are presented in sections 8 and 9.

LITERATURE REVIEW

Lifelong Learning, Internet Technologies, and Information Technology

In the field of IT at the Central University of Technology (CUT), there is a module called Internet Technologies. The subject focuses on the foundational concepts, tools, and systems that enable the operation and development of the Internet. It covers the technical aspects of how the Internet works, including architecture, protocols, and technologies that support online communication, web development, and the exchange of data across networks. Although lifelong learning is frequently portrayed as a worthwhile and essential endeavour in the rapidly evolving world of today, its actual goal must be recognized even in the context of Internet Technologies subject.[6] At its core, lifelong learning seeks to guarantee that stakeholders (students, academic staff, and support staff) continue to be knowledgeable, flexible, and able to handle changes in both their personal and professional lives. The viewpoint of Fidalgo and Thorman is consistent with the findings of this study that, in an era characterized by rapid technical breakthroughs such as AI, skills might become outdated quickly.[7] Thus, the main objective of lifelong learning is to promote ongoing development on both a cerebral and practical level, enabling stakeholders to stay current in their fields of interest and adapt to changing circumstances.[8] For example, as new tools, programming languages, networking protocols, and technologies are developed, experts in the IT sector are expected to keep up to date on their knowledge.[9] This adaptability is paramount for achieving both professional success and personal satisfaction within a knowledge-centric society.

In the pursuit of enhanced comprehension, lifelong learning, as articulated by Ngo, empowers various stakeholders, including institutions and governmental bodies, to actively engage in the realization of sustainable development goals (SDGs) by cultivating an ethos of perpetual advancement and knowledge exchange. For instance, as technological advancements progress and environmental issues escalate, information technology students endowed with contemporary skills are more suitably equipped to devise and implement groundbreaking solutions that address sustainability dilemmas such as energy optimization, waste reduction, and climate change adaptation. Through the commitment to continuous education, they are capable of adjusting to the most recent green technologies, facilitating the digital transformation of sectors, and advocating for environmentally sustainable practices, thereby making considerable advancements toward global sustainability objectives.

Nevertheless, beyond the mere necessity of keeping pace with technological advancements, the more profound inquiry is: what should lifelong learning empower us to accomplish at a societal level? Ideally, the purpose of lifelong learning should go beyond individual success and economic productivity. It ought to foster critical analysis, ethical accountability, and informed citizenship. By persistently interacting with new knowledge and varied viewpoints, individuals evolve into more effective contributors to their communities and develop greater capacity for tackling intricate global issues, such as climate change, social disparity, or digital privacy.[10] In this sense, lifelong learning contributes to the broader goal of creating a more enlightened, responsible, and collaborative society where individuals are not only equipped with technical skills but are also aware of the social and ethical implications of their knowledge. This can be done by emphasizing the ethical implications of technology, including issues like data privacy,

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[6] Gedrimiene et al., "Artificial Intelligence (AI)-Enhanced Learning Analytics (LA) for Supporting Career Decisions: Advantages and Challenges from User Perspective."

[7] Antonio Augusto Fidalgo-Neto et al., "Interdisciplinarity and Teacher Education: The Teacher's Training of the Secondary School in Rio de Janeiro—Brazil," *Creative Education* 5, no. 4 (2014): 262–72.

[8] David Mhlanga, "Open AI in Education, the Responsible and Ethical Use of ChatGPT Towards Lifelong Learning," *SSRN Electronic Journal*, 2023, https://doi.org/10.2139/ssrn.4354422.

[9] Thi Thuy An Ngo, "The Perception by University Students of the Use of ChatGPT in Education," *International Journal of Emerging Technologies in Learning (Online)* 18, no. 17 (2023): 4.

[10] Soha Rawas, "ChatGPT: Empowering Lifelong Learning in the Digital Age of Higher Education," *Education and Information Technologies* 29, no. 6 (2024): 6895–6908.

cybersecurity, and the digital divide in Internet technologies, subject and design group projects that require students to collaborate, and simulating real-world environments where teamwork and communication are essential.

Ultimately, the question of what the study aims to achieve through lifelong learning is one of balance. On the one hand, it is necessary to focus on practical outcomes, such as enhancing employability, economic productivity, and adaptability in a competitive global market. On the other hand, lifelong learning should also aim to enrich individuals holistically, fostering creativity, empathy, and a sense of purpose that transcends mere professional achievement.[11] By adopting a more expansive view of lifelong learning, one that nurtures both the mind and the character, societies can aspire to cultivate well-rounded individuals who not only excel in their careers but also contribute meaningfully to the betterment of humanity. This is more prevalent among IT students at CUT who are involved in projects that are linked to the society that they come from, to inspire them to assist the community with creative solutions to their problems.

Artificial Intelligence in Internet Technologies Module

Learning through the Internet has become increasingly important for people. Computers and computer-related systems were the initial form of AI in education, but more recently, the form of online and web-based education platforms has emerged.[12] The progress of AI technology and its incorporation into daily life is shaping how individuals encounter information, communicate, acquire knowledge, and form judgements.[13] According to Chen *et al*, AI conjures up images of supercomputers, machines capable of immense processing, including adaptive behavior, such as including sensors, and other capabilities, enabling them to function and think like humans, and improving their interaction with humans in the process.[14] The term AI commonly refers to systems that employ machine learning algorithms, robotics, and rule-based approaches to automate processes and forecast outcomes.[15]

According to the findings of Chen *et al*, AI has significantly improved student learning within Internet Technologies by enabling the customization and personalization of online learning materials.[16] Kuleto *et al.* observed that higher education institutions investing in AI-driven internet technologies will gain substantial advantages, as AI opens up numerous educational opportunities in digital and web-based environments.[17]

Types of Internet-Based Education Using Artificial Intelligence Applications

Internet-based education is popular when using AI applications. Huang *et al.* highlight that AI applications in internet-based education can take many forms, including adaptive learning platforms, automated teaching evaluations, and virtual classrooms, all of which enhance the learning experience for students studying Internet Technologies, etc.[18] The concepts of adaptive learning platforms, automated teaching evaluations, and virtual classrooms are expounded in the following sections.

Adaptive Learning

Adaptive learning has demonstrated significant potential in higher education, catering to students with varied educational backgrounds, learning preferences, and paces. The use of AI contributes to the development of adaptive learning, a process that involves data mining, intelligent teaching systems, learning analytics, and real-time analysis. [19] Through the implementation of adaptive learning methodologies, instructors possess the capacity to develop tailored resources and activities that

[11] Lijia Chen, Pingping Chen, and Zhijian Lin, "Artificial Intelligence in Education: A Review," *IEEE Access* 8 (2020): 75264–78.
[12] Chen, Chen, and Lin, "Artificial Intelligence in Education: A Review."
[13] Poquet and De Laat, "Developing Capabilities: Lifelong Learning in the Age of AI."
[14] Chen, Chen, and Lin, "Artificial Intelligence in Education: A Review."
[15] Valentin Kuleto et al., "Exploring Opportunities and Challenges of Artificial Intelligence and Machine Learning in Higher Education Institutions," *Sustainability* 13, no. 18 (2021): 10424.
[16] Chen, Chen, and Lin, "Artificial Intelligence in Education: A Review."
[17] Kuleto et al., "Exploring Opportunities and Challenges of Artificial Intelligence and Machine Learning in Higher Education Institutions."
[18] Thwe and Kalman, "Lifelong Learning in the Educational Setting: A Systematic Literature Review."
[19] Thwe and Kalman, "Lifelong Learning in the Educational Setting: A Systematic Literature Review."

specifically cater to the diverse learning requirements of individual students, thereby facilitating an effective educational experience for each learner.[20]

Instructors can utilize adaptive platforms to deliver resources and content that significantly enhance students' comprehension of concepts. The advancement of artificial intelligence suggests that adaptive learning will be instrumental in fostering equitable access to personalized educational experiences.

Teaching evaluation

Artificial intelligence-based teaching evaluation instruments empower educators to analyze, improve, and tailor their pedagogical approaches through insights derived from data analytics.[21] Hill and Grossman noted that the teacher evaluation tools are going through significant change. According to Huang *et al*. teaching evaluation can be made easier and provide convenience with artificial intelligence technologies such as image recognition, prediction systems, and computer vision.[22] These tools enable educators to personalize learning by automating feedback, grading, and providing real-time insights.

Virtual classroom

In order to create a contextual learning environment, teachers can simulate difficult-to-explain teaching scenarios using virtual classroom technology.[23] The concept of a virtual classroom closely resembles that of a traditional one, except that in this digital setting, an instructor conducts lessons remotely through a computer camera, while students attend the class from their own spaces, viewing the lecture on their personal computers.[24] Despite the physical separation, the core teaching and learning dynamics remain like those in a conventional classroom environment.

Artificial Intelligence in Lifelong Learning

Since AI is a phenomenon that is here to stay, it has a bearing on lifelong learning; hence, modules such as Internet technologies should embrace the concept to prepare students for the world of uncertainty. This would require the curriculum of Internet technologies at a University of Technology (UoT) to be reviewed. As industries evolve and new skills emerge, stakeholders, in this case, Internet Technologies students, are increasingly required to adapt to changing environments and expectations. This necessity for continuous education is not merely a trend but a fundamental shift in how learning is approached throughout our lives. To enhance learning in the Internet Technologies subject, educational materials are made available on the internet for students to access at any time and learn beyond the classroom. Allowing the traditional model of education to be replaced by more dynamic, flexible, and responsive learning pathways, as depicted in Figure 1.

[20] J L Rivera Muñoz et al., "Systematic Review of Adaptive Learning Technology for Learning in Higher Education," *Eurasian Journal of Educational Research* 98, no. 98 (2022): 221–33.
[21] Heather Hill and Pam Grossman, "Learning from Teacher Observations: Challenges and Opportunities Posed by New Teacher Evaluation Systems," *Harvard Educational Review* 83, no. 2 (2013): 371–84.
[22] Thwe and Kalman, "Lifelong Learning in the Educational Setting: A Systematic Literature Review."
[23] Thwe and Kalman, "Lifelong Learning in the Educational Setting: A Systematic Literature Review."
[24] Swapnil Alhat, "Virtual Classroom: A Future of Education Post-COVID-19.," *Shanlax International Journal of Education* 8, no. 4 (2020): 101–4.

Figure 1: The relationship between Artificial Intelligence (AI) and Lifelong Learning[25]

Artificial Intelligence plays a pivotal role in this transformation. With its ability to analyze vast amounts of data, recognize patterns, and provide personalized experiences, AI is redefining the landscape of education and skill development. Artificial intelligence significantly augments conventional pedagogical approaches by integrating groundbreaking technologies that render education increasingly accessible, efficient, and customized to meet individual requirements.[26] From sophisticated tutoring systems that provide instantaneous feedback to adaptive learning environments that modify content by learner performance, AI equips students with the agency to navigate their educational paths autonomously.[27] This study proposes that the incorporation of artificial intelligence within the lifelong learning module focused on Internet technologies can facilitate inclusivity by accommodating a spectrum of learning styles and requirements. It serves to mitigate obstacles for learners who may encounter impediments to conventional education, such as temporal limitations, geographical constraints, or varying abilities.[28]

Consequently, individuals are allowed to pursue knowledge and skills at their rhythm, thereby cultivating a culture of perpetual enhancement and flexibility. Nevertheless, the prevailing deficiencies in infrastructure concerning Internet Technologies must not be overlooked. In the absence of the requisite infrastructure, students at CUT and within Internet Technologies may experience delays in the adoption and experimentation with emerging technologies such as 5G, cloud computing, and advanced AI-driven tools, thereby placing them at a distinct disadvantage in aligning with global advancements in Internet Technologies.

Navigating an increasingly complex world, the intersection of AI and lifelong learning in Internet Technologies is not only reshaping the way knowledge is acquired but also equipping us with the tools necessary to thrive in an ever-changing landscape.[29] This synergy between technology and education holds the promise of unlocking new opportunities, empowering students to reach their full potential, and preparing them for the challenges of tomorrow.

Artificial Intelligence tools for lifelong learning

Artificial intelligence (AI) tools have become essential elements in the lifelong learning environment, dramatically altering the way people learn new information and skills, which can assist students in using

[25] Mhlanga, "Open AI in Education, the Responsible and Ethical Use of ChatGPT Towards Lifelong Learning."
[26] David Ernesto Salinas-Navarro et al., "Using Generative Artificial Intelligence Tools to Explain and Enhance Experiential Learning for Authentic Assessment," *Education Sciences* 14, no. 1 (2024): 83.
[27] Hongzhi Yang and Suna Kyun, "The Current Research Trend of Artificial Intelligence in Language Learning: A Systematic Empirical Literature Review from an Activity Theory Perspective," *Australasian Journal of Educational Technology* 38, no. 5 (2022): 180–210.
[28] Thwe and Kalman, "Lifelong Learning in the Educational Setting: A Systematic Literature Review."
[29] Mhlanga, "Open AI in Education, the Responsible and Ethical Use of ChatGPT Towards Lifelong Learning."

internet technologies.[30] As a result, various institutions of higher learning have been adopting these tools.[31] With the increasing globalization of educational resources brought by these tools, students should be equipped to select relevant tools for their learning.

These tools—which are detailed in Table 1.1—use cutting-edge algorithms and machine learning powers to deliver individualized learning experiences that let students interact with the material in ways that suit their requirements and preferences.

Table 1: Artificial Intelligence tools[32]

AI tools	Description	AI features
Coursera	Online learning platform offering courses from top universities.	Personalization algorithms recommend courses based on user interests and previous learning history.
edX	Online educational platform with a variety of courses.	AI for grading and feedback personalized course recommendations.
Duolingo	Language-learning platform using gamification.	Adaptive learning adjusts exercise difficulty based on user performance.
Khan Academy	Free educational resources across various subjects.	Personalized dashboards track progress and suggest tailored content.
IBM Watson Education	AI-powered tools to enhance teaching and learning.	Analyzes performance data to customize learning experiences and identify support areas.
Socratic by Google	AI-powered learning app for various subjects.	Uses image recognition to provide explanations and resources based on user queries.
Grammarly	AI writing assistant for improving writing skills.	Analyzes text for grammar, style, and tone, providing real-time feedback.
Quizlet	Study tool using flashcards and quizzes.	Intelligent algorithms adapt question frequency and type based on user knowledge.
Edmodo	Social learning platform for educators and students.	AI-driven insights track student engagement and performance for targeted interventions.

As stipulated by the authors, Salinas-Navarro *et al*. personalization is one of the most noteworthy features of AI systems for lifelong learning.[33] The one-size-fits-all approach taken by traditional educational methods may not be sufficient to address the variety of learners' backgrounds, learning preferences, and rates of progress. Conversely, platforms powered by AI examine user data to generate personalized learning experiences. For example, they can modify the course material considering prior exchanges, offering focused suggestions that assist students in concentrating on their areas of weakness and enhancing their areas of strength. When people feel empowered to take charge of their education, this level of personalization improves motivation, engagement, and overall learning results.

Education hurdles can be significantly reduced by the availability of AI-powered solutions. These tools democratize learning possibilities by making resources available anytime, anywhere, to a wider audience, especially those in underserved or rural areas.[34] For instance, AI is used by online learning environments like Coursera and edX to suggest courses that fit users' interests and job objectives, enabling anybody to pursue professional growth regardless of geography. This flexibility fosters a culture of ongoing growth and curiosity by encouraging lifelong learners to engage with areas they are passionate about in addition to supporting self-directed learning.[35]

[30] Thwe and Kalman, "Lifelong Learning in the Educational Setting: A Systematic Literature Review."
[31] Chen, Chen, and Lin, "Artificial Intelligence in Education: A Review."
[32] Yang and Kyun, "The Current Research Trend of Artificial Intelligence in Language Learning: A Systematic Empirical Literature Review from an Activity Theory Perspective."
[33] Salinas-Navarro et al., "Using Generative Artificial Intelligence Tools to Explain and Enhance Experiential Learning for Authentic Assessment."
[34] Sahan Bulathwela et al., "Artificial Intelligence Alone Will Not Democratise Education: On Educational Inequality, Techno-Solutionism and Inclusive Tools," *Sustainability* 16, no. 2 (2024): 781.
[35] Fidalgo-Neto et al., "Interdisciplinarity and Teacher Education: The Teacher's Training of the Secondary School in Rio de Janeiro—Brazil."

The Gaps in the Literature

The topic of AI and lifelong learning for IT students is still developing. The lack of emphasis on lifelong learning itself is one obvious gap. According to Gedrimiene *et al.*, the potential of AI to facilitate learning outside of formal educational frameworks—such as primary, secondary, and tertiary education—remains significantly underexplored in comparison to its applications within these traditional settings.[36] The swift progression of technological innovations poses substantial challenges for students specializing in Internet Technologies, as it necessitates continuous enhancement of competencies throughout their careers.[37] Despite this necessity, there isn't a thorough examination in the literature regarding the ways in which AI can be tailored to meet the requirements of lifelong learning. Moreover, a notable gap persists in the literature concerning ethical considerations, particularly those related to data privacy. Given that lifelong learning requires extensive and often multiplatform interactions between learners and AI-based systems, there are heightened risks associated with the collection and utilization of personal data.[38] The research in this area is still growing, and there has been insufficient emphasis on the specific ethical and privacy challenges that arise when IT students engage with these technologies across various professional and educational contexts as part of their lifelong learning endeavors. The rapid advancement of technology presents challenges for Internet Technologies students, as it necessitates ongoing skill improvement throughout their careers.[39] Despite this necessity, there isn't a thorough examination in the literature of how AI might be customized to fulfill the demands of lifelong learning in the IT industry.

It is noted that Internet Technologies as a module at UoT can contribute meaningfully to student development by infusing AI and lifelong learning concepts, which can be overlooked in curriculum development.

THEORETICAL FRAMEWORK

This paper is underpinned by Activity Theory. Activity Theory is a sociocultural framework that helps explain how humans interact with their environment, tools, and social structures in goal-oriented activities.[40] It originated from the work of Soviet psychologists Lev Vygotsky, Alexei Leontiev, and Sergei Rubinstein in the early 20th century. In this research, AT contends that the phenomenon of lifelong learning for students in Information Technology (IT) is influenced by a complex interplay among learners, artificial intelligence instruments, and the extensive social and institutional context.[41] Learning is understood not merely as an individual cognitive activity but as a socially mediated process, where AI tools play a central role in shaping how students acquire and apply knowledge. According to AT, AI technologies function as mediators within the learning environment, influencing the extent to which IT students can engage with and benefit from educational opportunities. The theory underlines the importance of considering the broader activity system in which learning takes place, including the community of peers, mentors, and industry professionals, as well as the rules and norms that govern the use of AI technologies in education.

Moreover, Activity Theory highlights that contradictions or tensions may arise within the activity system.[42] For example, while AI offers personalized learning opportunities, it may also exacerbate the digital divide, creating barriers for students from marginalized communities. These tensions can either hinder learning or lead to transformative changes when resolved. Furthermore, the theory acknowledges that lifelong learning is an evolving process, continuously influenced by advancements in AI and shifts in industry demands.[43] As such, AT offers a valuable framework for scrutinizing not merely the direct effects

[36] Gedrimiene et al., "Artificial Intelligence (AI)-Enhanced Learning Analytics (LA) for Supporting Career Decisions: Advantages and Challenges from User Perspective."
[37] Thwe and Kalman, "Lifelong Learning in the Educational Setting: A Systematic Literature Review."
[38] Ammar Abulibdeh, Esmat Zaidan, and Rawan Abulibdeh, "Navigating the Confluence of Artificial Intelligence and Education for Sustainable Development in the Era of Industry 4.0: Challenges, Opportunities, and Ethical Dimensions," *Journal of Cleaner Production* 437 (2024): 140527.
[39] Thwe and Kalman, "Lifelong Learning in the Educational Setting: A Systematic Literature Review."
[40] Inna Artemova, "Bridging Motivation and AI in Education: An Activity Theory Perspective,"*Digital Education Review* 45(2024):59–69.
[41] Yang and Kyun, "The Current Research Trend of Artificial Intelligence in Language Learning: A Systematic Empirical Literature Review from an Activity Theory Perspective."
[42] Ilkka Tuomi, "Beyond Mastery: Toward a Broader Understanding of AI in Education," *International Journal of Artificial Intelligence in Education* 34, no. 1 (2024): 20–30.
[43] Poquet and De Laat, "Developing Capabilities: Lifelong Learning in the Age of AI."

of AI on the educational experiences of IT students but also the wider socio-cultural and institutional elements that influence the learning process over time. This theory is relevant for the study since it facilitates a comprehensive comprehension of how AI may enhance or impede lifelong learning within the swiftly evolving IT domain. To apply the theory, the research adhered to its six components: (1) subject; (2) objects; (3) tools; (4) rules; (5) community; and (6) division of labor, as illustrated in Figure 2.

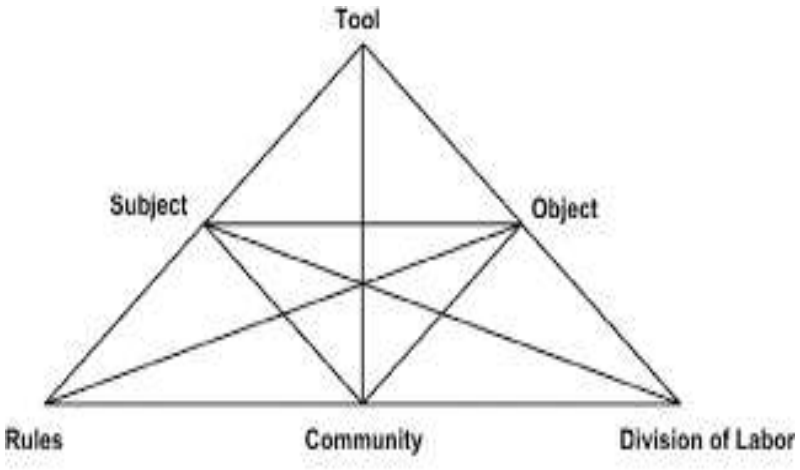

Figure 2: Activity Theory Components[44]

Under the first point (IT students as lifelong learners), concerning Activity Theory, the subject refers to the primary actor or group engaged in an activity.[45] In this research, the subjects are IT students engaged in lifelong learning. This allowed us to explore and observe how these students approach learning throughout their careers, their motivations, and the challenges they face when interacting with AI-driven educational tools. Concerning Object (Lifelong learning goals) represents the goal or purpose that drives the activity.[46] For IT students, the objective would be to continuously acquire new skills and knowledge to stay competitive in the rapidly evolving field of technology. This component allowed us to discuss how AI tools help (or hinder) the achievement of these learning objectives over time. In relation to tools/Artifacts (AI in learning), it refers to the mediators that subjects use to achieve their goals. AI-driven learning platforms, personalized learning algorithms, and adaptive educational tools are key tools in this research. This allowed us to discuss how AI as a tool influences learning activity, how it shapes learning behaviors, and the extent to which it personalizes or enhances learning experiences. Moreover, with reference to Community (Peers, mentors, industry professionals), it is the social context in which the activity takes place. For IT students, this includes peers, mentors, instructors, and industry professionals. How the AI tools facilitate or disrupt collaboration within this community, and whether AI creates new avenues for social interaction and professional development, were analyzed. The rules (Institutional and ethical guidelines) refer to either formal or informal norms governing the activity. This included institutional policies related to AI use in education, ethical concerns surrounding data privacy, or societal expectations regarding skill acquisition in IT. The investigation explored how rules shape the use of AI in lifelong learning, especially regarding inclusivity and equitable access to resources. With reference to Division of Labor (Roles in Learning and Technology Development): In Activity Theory, it refers to the distribution of tasks and responsibilities.[47] This component allowed us to explore how AI shifts the roles of educators, learners, and developers in the learning process. For instance, the research looked at how AI empowers students to take more control of their learning and whether it places greater emphasis on tech developers to design inclusive and accessible learning tools. Finally, the outcome (Transformative impact

[44] Poquet and De Laat, "Developing Capabilities: Lifelong Learning in the Age of AI."
[45] Poquet and De Laat, "Developing Capabilities: Lifelong Learning in the Age of AI"; Artemova, "Bridging Motivation and AI in Education: An Activity Theory Perspective."
[46] Poquet and De Laat, "Developing Capabilities: Lifelong Learning in the Age of AI"; Artemova, "Bridging Motivation and AI in Education: An Activity Theory Perspective."
[47] Poquet and De Laat, "Developing Capabilities: Lifelong Learning in the Age of AI"; Artemova, "Bridging Motivation and AI in Education: An Activity Theory Perspective."

of AI on lifelong learning) refers to the broader results of the activity system.[48] In this case, the analysis focused on how AI either transforms or limits lifelong learning for IT students. What are the long-term effects of using AI on skill acquisition, career advancement, and continuous learning? The basic answer to this question would be lifelong learning, which is discussed below.

METHODOLOGY

This study adopted a qualitative theoretical approach, underpinned by Activity Theory as the framework. This was a result of a review of various literature that speaks on AI, lifelong Learning, and enabling student learning environments through the teaching of IT. Activity Theory, rooted in the socio-cultural tradition of Vygotskian thought, provided a structured lens through which to examine the interrelated components of a learning activity system. The core elements of the framework—subject (students), object (lifelong learning goals), mediating artifacts (AI tools and applications), rules, community, and division of labour—are used to analyze how AI reshapes educational practices and interactions within the university setting.This theoretical lens facilitated an examination of how AI impacts learners' participation, autonomy, and engagement, as well as the evolving roles of instructors (as facilitators) and peers (as collaborators). The methodology emphasizes the historical and cultural dimensions of the learning environment, recognizing that the adoption and effectiveness of AI tools are influenced by institutional context, digital readiness, and the socio-technical dynamics within the CUT community.By analyzing theoretical scenarios and drawing insights from existing literature, this study constructed a conceptual model of AI integration that accounts for both the advantages and constraints of technology in supporting lifelong learning in a real-world higher education context.cVarious search engines were also used, such as Google Scholar, Web of Science, and Scopus. The intention was to ensure the selected literature related to AI and lifelong learning in higher education.

FINDINGS AND DISCUSSION

The findings are categorized in various sections or themes which emerged from the research. The first section, the challenges of AI in lifelong learning, is briefly discussed. While AI can enhance personalized learning and streamline educational processes, its implementation raises complex issues that must be addressed. The AI applications developed by the industry, such as virtual reality and augmented reality, are typically developed from the industry's perspective and may not be grounded in educational theories and research regarding effective student learning methods.[49] One of the primary hurdles in integrating AI with Internet Technologies is the need for modified AI solutions that accommodate diverse learning styles in online environments. The complexity arises from the challenge of aligning AI technologies with the existing digital frameworks and infrastructure that support internet-based education at CUT. This includes ensuring AI tools are compatible with web-based learning platforms, can function efficiently across varying levels of internet connectivity, and are adaptable to the interactive nature of internet technologies education, where students engage in activities like coding, networking, and simulations.

Furthermore, disparities in access to technology and the internet present significant challenges at CUT, as not all learners have the same opportunities to engage with digital educational tools.[50] Some students are unable to procure a laptop, and their home environments do not facilitate effective learning. This disparity engenders a digital divide that can obstruct educational outcomes, especially for underprivileged and marginalized student populations. The advent of AI-driven educational tools, though promising, may further intensify these inequities. In the absence of deliberate initiatives aimed at fostering inclusivity, these cutting-edge technologies risk remaining inaccessible to vulnerable groups, thus exacerbating the discrepancy in educational opportunities and reinforcing systemic barriers to education.[51] Addressing this issue requires a focus on both technological access and equitable implementation of AI resources at CUT, where most students come from underprivileged families.

[48] Poquet and De Laat, "Developing Capabilities: Lifelong Learning in the Age of AI"; Artemova, "Bridging Motivation and AI in Education: An Activity Theory Perspective."

[49] Hui Luan et al., "Challenges and Future Directions of Big Data and Artificial Intelligence in Education," *Frontiers in Psychology* 11 (2020): 580820.

[50] Marcia Håkansson Lindqvist et al., "Higher Education Transformation towards Lifelong Learning in a Digital Era–a Scoping Literature Review," *International Journal of Lifelong Education* 43, no. 1 (2024): 24–38.

[51] Ngo, "The Perception by University Students of the Use of ChatGPT in Education."

There is also a lack of research pertaining to accessibility and inclusion. Currently, CUT has a lack of Access to Modern Tools and Software due to cost and infrastructure. Internet Technologies often require access to specialized tools such as web development platforms, network simulators, and cloud services. Students without access to up-to-date hardware, software licenses, or cloud resources are excluded from fully engaging in practical learning experiences.

Studies conducted currently frequently fail to include how AI-driven resources for lifelong learning can be made available to a wide range of students, including those from underrepresented or economically disadvantaged backgrounds.[52] Future research must address these concerns and investigate how AI might be built to be more inclusive, as AI has the potential to worsen current disparities, especially through issues like cost and digital literacy.

The research into the impact of AI on lifelong learning for IT students revealed several pivotal insights regarding the effectiveness and transformative potential of AI-driven educational frameworks. The prominent findings encompass personalization and adaptive learning, ongoing feedback and immediate assessment, as well as augmented accessibility to educational resources.

On a positive note, the research findings elucidate that although artificial intelligence harbours considerable promise for enhancing lifelong learning within information technology education, it is imperative to meticulously consider aspects of equitable access, ethical implications, and the human dimensions of education.[53] When judiciously incorporated, AI has the capacity to fundamentally alter the way IT students engage in lifelong learning, thereby equipping them with the requisite tools to maintain relevance and adaptability in a perpetually evolving field. Artificial intelligence allows students to engage in learning irrespective of their geographical location.

The research highlighted the substantial influence of AI in tailoring educational experiences to suit the individual learner's needs.[54] Specifically, for students pursuing studies in the domain of information technology, there exist considerable benefits associated with AI systems that provide personalized learning trajectories, adaptive content, and instantaneous feedback.

The findings also suggest that by employing adaptive learning methodologies, educators are empowered to devise tailored resources and activities that cater to the specific learning requirements of each student, consequently ensuring an effective educational experience for all participants, particularly for those enrolled in the Internet Technologies course at the University of Technology.[55]

With the progression of artificial intelligence, adaptive learning is poised to substantially enhance the promotion of equitable access to personalized education for these learners. The research findings are submitted to reveal that virtual classrooms enable instructors to facilitate courses remotely while students participate from their respective locations.[56] This suggests that students can seamlessly collaborate on projects with their peers or instructors within virtual classroom environments, thereby addressing the existing research gap in accessibility and inclusion.

Finally, there isn't much research on human-AI cooperation in lifetime learning in the literature. Few researchers have looked at how AI systems can complement human mentors, instructors, and business professionals to give IT students a more comprehensive learning experience. Moreover, there is still a dearth of research on the actual application of AI in certification programs and professional learning settings.[57] There exists a compelling necessity for additional inquiries into the pragmatic applications of AI technologies, particularly within the realm of professional development for individuals in the IT sector. Addressing these deficiencies will facilitate the preparation of IT students to adeptly navigate the rapidly evolving technological landscape, while simultaneously fostering a profound comprehension of the integral role that AI plays in lifelong learning.

[52] Salinas-Navarro et al., "Using Generative Artificial Intelligence Tools to Explain and Enhance Experiential Learning for Authentic Assessment."
[53] Luan et al., "Challenges and Future Directions of Big Data and Artificial Intelligence in Education."
[54] Ngo, "The Perception by University Students of the Use of ChatGPT in Education."
[55] Kuleto et al., "Exploring Opportunities and Challenges of Artificial Intelligence and Machine Learning in Higher Education Institutions."
[56] Alhat, "Virtual Classroom: A Future of Education Post-COVID-19."
[57] Abulibdeh, Zaidan, and Abulibdeh, "Navigating the Confluence of Artificial Intelligence and Education for Sustainable Development in the Era of Industry 4.0: Challenges, Opportunities, and Ethical Dimensions."

RECOMMENDATIONS AND CONTRIBUTIONS TO SCHOLARSHIP

This paper offers the following recommendations:

- Institutions should invest in infrastructure and training to support the integration of AI in education.
- There should be a contextual adaptation of AI tools, considering cultural, institutional, and learner-specific needs.
- Policymakers and educators should work collaboratively to develop ethical frameworks and data protection policies for the use of AI in education.
- AI-driven learning models should be aligned with constructivist pedagogies to support deep, meaningful, and lifelong learning.
- This paper contributes to academic scholarship by:
- Offering a theoretical framework (Activity Theory) to analyze the integration of AI in lifelong learning for Internet Technologies students.
- Bridging the gap between educational theory and technology adoption, providing insights into how AI can be effectively harnessed to support learner autonomy and adaptability.
- Highlighting the importance of context-aware AI integration, which has implications for curriculum development, instructional design, and policy formulation.

Contributing to the discourse on lifelong learning in the digital age, especially in higher education and technical disciplines.

CONCLUSION

In rapidly evolving domains such as IT, the concept of lifelong learning has emerged as a fundamental aspect of both personal and professional growth. AI learning is a key driver in fostering a culture of continuous learning amongst learners in the field of information technology, as it can create a customized and flexible learning environment. One of the most noticeable benefits of AI advancement in lifelong learning is the impact it has on customized learning experiences. Educational work, especially traditional education, features a one-size-fits-all approach.

Interaction, on the other hand, exposes AI-powered systems to the different learning needs, rates, and styles of the students. AI systems enable the recognition of learners' achievement levels over time and thus increase or decrease challenges, provide feedback, and recommend further education resources. Students can also use real-time interactions with learning materials to modify their preferred methods of course delivery. This is very important in IT because the learning curve is always high due to rapid changes in technology and tools. Such mechanisms also empower students so that they are not left behind but rather progress with the acquisition of new skills.

The inclusion of artificial intelligence in education brings many advantages in terms of fostering self-learning throughout one's life; however, it does have some shortcomings. One of the issues that stands out is the emphasis on ensuring that learners from various backgrounds have equal access to AI technologies. Moreover, ethical issues related to the use of AI for data collection and personalized education also raise concerns about privacy, authorization, and exposure to algorithmic bias.

Educational institutions are obliged to confront issues related to equity, ethics, and accessibility to guarantee that AI-facilitated lifelong learning benefits all learners. The success of lifelong learning depends on the strategic and effective use of AI for driving innovation.

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