The Influence of Artificial Intelligence Tools on Student Performance in e-Learning Environments: Case Study

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Abstract: This study investigated the impact of AI-powered personalized learning tools on the academic performance and perceptions of pre-service student teachers enrolled in the Educational Technology course, a compulsory component of the Professional Postgraduate Diploma in Teaching program at Ajman University. A quasi-experimental design was employed with 55 students in the experimental group and 55 in the control group. The experimental group utilized AI-powered tools within the Moodle platform, while the control group received traditional instruction. Pre- and post-tests, along with a rubric-based assessment and a questionnaire, were administered to assess performance, knowledge retention, critical thinking, motivation, and engagement. Statistical analysis revealed significant differences between the groups, favoring the experimental group in terms of academic performance and knowledge retention. Additionally, students in the experimental group demonstrated higher levels of critical thinking, motivation, and engagement. These findings underscore the transformative potential of AI-powered personalized learning tools in teacher education. By integrating AI into educational practices, institutions can revolutionize e-learning by providing personalized instruction, intelligent tutoring, automated grading, and adaptive learning experiences. This can enhance student engagement, improve learning outcomes, and reduce the workload of educators. Ultimately, AI empowers institutions to create more effective and inclusive learning environments that cater to the diverse needs of students and prepare them for the future.

Keywords: Academic performance, Artificial intelligence, Educational environment, Pre-service teachers

1. Introduction

We are living in an era where everything keeps on changing and developing, and so do approaches and innovative techniques in teaching and learning. It is, therefore, imperative for these institutions, academicians, and researchers to keep tracking change once in a while (Alemán et al., 2019; Bahja, Kuhail and Hammad, 2022; Salama and Hinton, 2023). Pre-service teacher training institutes also make all their level best to keep an update on the latest practices and equip potential educators with skills to adapt to evolving information technology. And, over the past few years, artificial intelligence (AI) is fast emerging as one of the most crucial enablers in this pursuit (Pedró et al., 2019; De la Higuera, 2019; Alam, 2021; Eggert, 2021; George and Wooden, 2023). This marks the pursuit of leading-edge educational methods in the ongoing education revolution, representing only a very tiny part of the very big range that AI-driven tools offer teachers and trainers. These tools could be very handy in the reformation of old-aged pedagogical practices and may provide the students with a dynamic, immersive, and customized learning experience (De la Higuera, 2019; Gupta and Bhatia, 2019).

In this regard, AI can be taken as a very important determinant in the successes of the education revolution to the current generations of learners and teachers. Teachers can provide personally designed learning experiences with the aid of available tools to adjust instructions and learning material according to the needs and preferences of every student (Bhapkar and Ranjane, 2013; Kadaruddin, 2023; Christopoulos et al., 2020; Qushem et al., 2021; Gupta and Bhatia, 2019). For example, AI may eventually empower adaptive learning platforms to produce insights based on performance data and, in this way, suggest ways in which learners could be assisted to improve or get back on track (Pedró et al., 2019). In the same manner, chatbots and virtual assistants operating with the intelligence of AI can keep the students on the right track by answering queries and helping to navigate the content (De la Higuera, 2019; Adair, 2023; Chen, Chen and Lin, 2020). Additionally, through AI, the data will have to be sifted by the use of the AI algorithms for patterns and trends that will help educators take data-driven decisions on strategies of imparting knowledge and also on the development of data-driven curricula (Gupta and Bhatia, 2019; Adair, 2023).

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Given that we are at a crossroads from where technology and intelligence in education need to be connected, it is important that we reflect more emphatically on the influence of intelligence (Pedró et al., 2019; De la Higuera, 2019). The important fact is the understanding of the actual impacts and consequences on the achievements, state of readiness, and aspirations of educators to become an influence and significant role in shaping the world of contemporary education (Pedró et al., 2019; De la Higuera, 2019; Adair, 2023; Chen, Chen and Lin, 2020). In addition, the incorporation of intelligence technologies, in settings signifies a significant change, in teaching methods (Gupta and Bhatia, 2019; Adair, 2023; Chen, Chen and Lin, 2020). Examining how AI impacts education allows researchers and educators to understand its potential to boost student participation thinking abilities and academic achievements (Pedró et al., 2019; De la Higuera, 2019; Chen, Chen and Lin, 2020).

Therefore, it is necessary to conduct empirical research that explores the impact of integrating AI into teaching practices to inform evidence-based practices and policy decisions in education (Pedró et al., 2019; De la Higuera, 2019; Adair, 2023).

1.1 What is AI

Artificial Intelligence (AI) is a term that refers to the process of simulating human intelligence in computers, so that they can think and behave like human beings. The ultimate objective of AI is to manufacture machines that perform jobs typically done by intelligent people such as visual perception, speech recognition, making decisions, learning and translation (Fetzer, 1990). AI systems are designed to analyze and interpret data, learn from patterns, and make decisions based on that learning.

Fetzer (1990) define AI as "*the study of how to make machines behave intelligently, to solve problems and achieve goals in the kinds of complex situations in which humans require intelligence to achieve goals*."

John McCarthy one of the pioneers of AI, define it as "*It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.*" (McCarthy, 2007).

In its most basic essence, artificial intelligence is a discipline that merges computer science with comprehensive datasets to facilitate problem-solving. Additionally, it includes sub-domains such as machine learning and deep learning, often mentioned in tandem with artificial intelligence. These areas involve AI algorithms that aim to develop expert systems capable of making predictions or classifications by analyzing input data (Ertel, 2018).

1.2 AI in Education

Artificial Intelligence (AI) is increasingly making significant contributions to the field of education, transforming the way students learn, educators teach, and educational institutions operate (Loeckx, 2016; Seldon and Abidoye, 2018; Zhai et al., 2021; Zhang and Aslan, 2021). Loeckx (2016) mentioned that AI can serve as a valuable educational tool, alleviating the responsibilities of both teachers and students while fostering effective learning experiences. In addition to ongoing educational reforms like the digitization of educational resources, gamification, and personalized learning, there exist numerous prospects for the development of AI applications in education. One notable example is the systematic utilization of AI techniques to model interactive and adaptive educational programs, creating individualized learning environments. This compensatory approach addresses the scarcity of teachers through the implementation of Intelligent Tutoring Systems (ITS) (du Boulay, 2016).

ITS offers personalized learning experiences through four main avenues: monitoring student input, presenting appropriate assignments, providing effective feedback, and facilitating interfaces for human-computer communication (Seldon and Abidoye, 2018). The proliferation of ITS across various subjects suggests an evolving role for teachers, prompting a potential reconceptualization of education. Nevertheless, swift technological advancements inherently introduce numerous risks and challenges. For example, there are concerns among teachers about whether artificial intelligence poses a threat to their profession. Some researchers ponder whether the advancement of artificial intelligence might challenge or even replace teachers, akin to the way many jobs are being automated (Lacity and Willcocks, 2017). It is increasingly recognized that as AI continues to progress, teachers' professional roles will necessitate modification, leading to the emergence of new organizational structures.

Emerging challenges also encompass student attitudes toward these changes (Flogie and Aberšek, 2015). While students, as digital natives, can leverage AI to enhance learning outcomes, there exists the possibility that they

may struggle to employ AI techniques appropriately within a specific educational context, potentially resulting in negative attitudes toward learning (Ijaz, Bogdanovych and Trescaket, 2017).

In the realm of e-learning, AI has demonstrated remarkable potential to significantly improve both teaching and learning outcomes by offering personalized learning experiences, adaptive feedback, and streamlined data analysis. AI-powered systems, including intelligent tutoring and adaptive learning platforms, can process large amounts of student data in real-time, allowing educators to customize content according to each learner's unique needs, preferences, and progress (Luckin et al., 2016; Zawacki-Richter et al., 2019). These tools not only enhance personalization but also create dynamic and interactive educational environments, which foster greater student engagement and motivation (Baker, smith and Anissa, 2019). For instance, AI algorithms can detect gaps in a learner's knowledge and dynamically adjust the complexity of tasks, providing personalized feedback and targeted recommendations for improvement (Luckin et al., 2019). By offering such adaptive feedback, AI systems help learners develop critical thinking skills and encourage deeper learning (Chen, Chen and Lin, 2020).

Furthermore, AI enhances the efficiency of data analysis by continuously collecting and interpreting student performance data. This real-time monitoring allows educators to track learners' progress closely and intervene when necessary (Kulik and Fletcher, 2016). With these capabilities, teachers can manage larger class sizes more effectively and make data-driven decisions that refine instruction. By tailoring content to meet individual student needs, AI also promotes educational equity, ensuring that learners of different abilities and backgrounds receive the support they need (Woolf, 2018).

AI tools in e-learning environments not only improve individual learning outcomes but also equip educators with actionable insights to optimize teaching strategies. These technologies play a pivotal role in fostering flexible, personalized, and more effective learning experiences in both digital and blended learning settings.

This study seeks to investigate the impact of AI on pre-service teachers' academic performance and perspectives in an e-learning context. By focusing on AI-driven tools within the Educational Technology course.

This research explores how AI affects both measurable performance outcomes and the perceptions of future educators. In doing so, the study contributes to the growing body of knowledge on AI's influence in reshaping education and preparing teachers for the evolving demands of modern classrooms.

1.3 Previous Studies

A study conducted by Kuleto et al. (2021) explores the opportunities and challenges of implementing artificial intelligence (AI) and machine learning (ML) in higher education institutions (HEIs). It highlights how AI and ML can be used to enhance teaching and learning, such as through adaptive learning technology, AI-powered chatbots, and automating certain tasks to free up teacher time. The study also provides an overview of AI and ML, including the differences between supervised and unsupervised learning. The research methodology and results are also presented, including the use of partial least squares structural equation modeling (PLS-SEM) to analyze data from 103 students in Serbia. Its results point out that AI and ML have the potential to improve learning through the development of student skills, collaborative learning environments, and accessible research environments.

In their study, Ocaña-Fernández, Valenzuela-Fernández and Garro-Aburto (2019) extrapolate the effects of the new technologies associated with artificial intelligence (AI) in higher education. The researchers have conducted a literature review to explore the impact of AI on educational practices, the challenges and ethical considerations associated with its implementation, and the necessary digital competencies that universities should develop to prepare students for a technologically advanced future. The article synthesizes various sources, including academic papers, books, and reports, to provide an overview of the current state of AI in education and to discuss the potential of AI to transform educational experiences through personalized learning and intelligent tutoring systems. It also addresses the broader implications of AI for society, such as the need for effective policies and the importance of digital literacy.

In a recent study by Annamalai et al. (2023) aimed to understand students' motivation to learn English using chatbots based on self-determination theory (SDT). A case study design was employed to gather qualitative data. The researchers conducted interviews with 25 undergraduate students in Malaysia to understand how chatbots support competence, autonomy and relatedness in language learning. The findings revealed that chatbots can improve language skills through repetition, assessment, multimedia resources and feedback. They also allow flexible learning in terms of time and location. However, chatbots lack emotional environment and

may provide inaccurate information. Students suggested integrating chatbots for assessment with traditional classroom teaching. Another study by Trisoni et al. (2023) examined the effect of artificial intelligence (AI) in improving student achievement at the senior high school level. The research used a quantitative survey model approach, including online-based Google forms and in-depth interviews with teachers and students to collect data on how AI can help teachers design lessons that better assist students in learning. The findings suggest that AI can help teachers achieve student competency in teaching and learning, and help students improve achievement during the learning process.

Ling (2023) investigated the impact of AI-mediated language instruction compared to traditional instruction on English learning achievement, L2 motivation, and self-regulated learning among EFL learners in China. In this experimental research, a control-experimental group post-test only research design was used. Sixty undergraduate students were randomly assigned, 30 to the control group receiving regular classroom instruction and 30 to the experimental group to receive instructions using the Duolingo AI platform. Both of the groups took a pre- and post-test to measure their English language proficiency in separate areas of listening, reading, writing, and speaking. Quantitatively, the results presented evidence that the experimental group's scores were significantly higher than those of the control group. In the study by Cruz-Jesus et al. (2020), using artificial intelligence techniques in the process of prediction, it was intended to identify features and patterns that would describe critical aspects of the academic achievements students in high schools within the Portuguese public-school system would attain. The methodology of the study involves the use of artificial intelligence (AI) techniques to predict academic achievement (AA). The researchers employed various AI methods, including Artificial Neural Networks (ANNs), to analyze a dataset of 110,627 students from Portuguese public high schools in the academic year 2014/2015. The dataset included demographic information, financial information about students' families, and details about the schools and their locations. The study concludes that AI methods, particularly RF, can provide a valuable tool for predicting AA and could be used to identify students at risk of failing early in the academic year. This could potentially lead to interventions that improve student outcomes and reduce the rate of school dropouts. The authors suggest that implementing AI strategies in education could significantly enhance the prediction performance of AA and provide policymakers with actionable insights to improve educational systems.

Zhang et al. (2023) studied the acceptance of AI among prospective teachers with the help of an extended TAM. The researchers aimed at finding the factor structure of the acceptance of AI and differences by gender among 452 pre-service teachers in Germany. The statistical analysis applied the structural equation model. The tests for measurement invariance examine whether there have been differences in responses by gender in the process of gauging the level of acceptance of AI among the pre-service teachers. The latent mean analysis revealed significant average differences between male and female pre-service teachers for the factors of AI anxiety and perceived enjoyment, with females scoring higher in AI anxiety on average. A recent study by Butakor (2023), examined pre-service teachers' beliefs about the role of artificial intelligence in higher education in Ghana. A quantitative descriptive design was employed to examine the perceptions of 231 preservice teachers regarding AI tools. The results revealed that the majority were familiar with AI and believed it could enhance student performance and potentially serve as a substitute for teachers in certain contexts. However, most participants also reported feeling anxious about using AI systems for learning. The study recommends more training and support for pre-service teachers to help them integrate AI into teaching and learning, especially post-pandemic.

While the previous research has demonstrated the positive effects of AI in higher education, a comprehensive empirical investigation of AI's impact on teacher preparation is lacking. This study aims to fill this research gap by examining the effectiveness of integrating AI into teacher education programs.

1.4 Purpose and Significance of the Study

The primary objective of this study is to examine the impact of artificial intelligence (AI)-powered tools on the academic performance and perspectives of pre-service teachers. Using an experimental design, the study compares an experimental group exposed to AI-enhanced learning environments with a control group following traditional teaching methods. By directly comparing these two groups, the study aims to reveal measurable differences in academic outcomes, such as knowledge retention, critical thinking, and skill acquisition.

The study focuses on two key dimensions: performance and perspectives. The performance dimension investigates tangible academic results, such as improvements in test scores and skill enhancement, facilitated by AI-powered personalized learning tools. The perspectives dimension explores how pre-service teachers

perceive and adapt to the integration of AI in their professional training, considering changes in their attitudes, adaptability, and their roles within an AI-influenced educational landscape.

This study's significance lies in its contribution to the growing body of research on AI in education. By comparing the AI-enhanced experimental group with the control group, the research offers insights into how AI can transform teaching and learning outcomes and prepares future educators to navigate and adapt to evolving educational technologies.

1.5 Study Questions

In light of the above, the objective of this study is to examine the impact of Artificial Intelligence (AI) on the academic performance and perspectives of pre-service student-teachers enrolled in an Educational Technology course. Specifically, the study aims to explore how the integration of AI-driven tools into the educational environment influences student achievement, knowledge retention, critical thinking skills, motivation, and engagement.

To address this objective, the primary research question guiding the study is: What are the effects of integrating AI-driven tools into an Educational Technology course on the academic performance and perspectives of pre-service student-teachers? To provide insights into this overarching question, the researchers formulated the following subsidiary research questions:

Q1. How does AI-driven tools influence academic performance in the Educational Technology course, as measured by achievement tests?

Q2. To what extent does the integration of AI-driven tools impact the development of critical thinking skills among pre-service student-teachers?

Q3. What are the differences in motivation levels between students in the experimental group and the control group?

Q4. How does engagement in the Educational Technology course vary between students exposed to AI-driven tools and those exposed to traditional teaching methods?

Q5. What are the perspectives of pre-service student-teachers regarding the use of AI-driven tools in educational environments, particularly?

Q6. What are the potential differences in student perspective levels based on gender?

2. Research Design and Methods

2.1 Study Design

This study adopted a quasi-experimental design to examine the impact of AI-powered learning tools on the academic performance and perceptions of pre-service teachers. The sample selection was intact groups -based, unlike a true experimental design, participants were not randomly assigned; instead, they were naturally grouped according to their enrollment in specific course sections. This distinction is a defining feature of quasi-experimental research.

The study involved two sections of the Educational Technology course, each serving as a distinct group for comparison. Section 1 comprised the experimental group, where AI-powered tools were integrated into the e-learning platform Moodle. Section 2 represented the control group, which was taught using traditional methods without any AI intervention. The study followed a single-blind design, where participants were unaware of the group to which they were assigned, ensuring unbiased responses. Both groups covered the same content—unit 4, "Instructional Design"—allowing for a direct comparison of learning outcomes (Table 1). This design facilitated a rigorous analysis of how AI integration influenced academic performance and shaped student perspectives.

The study was conducted at Ajman University during the fall semester 2023-2024, from September 2023 to January 2024. Data collection involved pre- and post-tests, as well as a questionnaire designed to capture both performance metrics and perceptions of AI integration. Figure 1 illustrated the study's design.

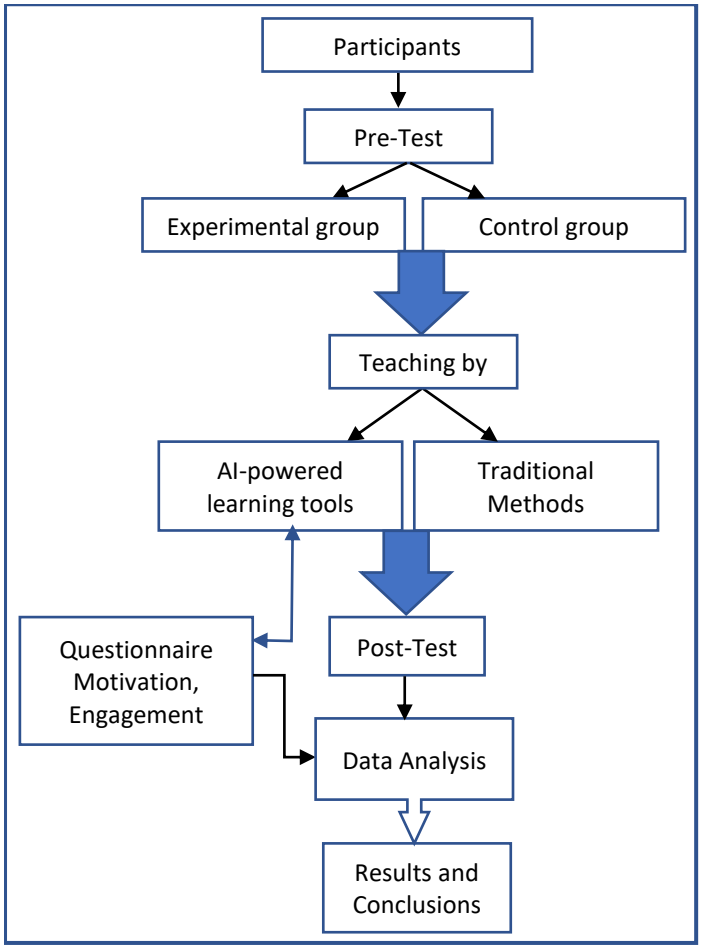

Figure 1: Experimental design of the study

2.2 Participants

The participants included 110 pre-service teachers enrolled into two sections of the Educational Technology course, a compulsory component of the Professional Postgraduate Diploma in Teaching program. Eligibility criteria required that participants be enrolled in the course during the specified semester and willing to participate. No additional exclusion criteria were applied.

2.3 Sample Size Determination

The sample size was determined using G*Power software, which calculated that a minimum of 102 participants (51 per group) would be required to detect a medium effect size (Cohen's d = 0.5) with 70% power at the 0.05 significance level. To ensure sufficient statistical precision, the final sample included 110 participants, accounting for potential dropouts.

2.4 Data Collection Instruments

2.4.1 Achievement test

Researchers developed the achievement exam based on the content of topic 4 of the Educational technology course to investigate how AI-driven tools affects student achievement. A specification table was designed for this exam based on Bloom's cognitive domain taxonomy (see Table 4). It consisted of 20 multiple-choice questions in its final form. There are four options (A, B, C, D) for each item: made up of one correct answer (key) and three wrong answers (distracters). A correct response earned one mark, while a wrong response earned zero points. There was a maximum score of 20, and the test lasted 60 minutes. To assess the internal consistency of the Achievement Test, a random sample of 30 test-takers completed the final test.

Table 1: Post-test (achievement test) specification table

Topics	# of Hours	Weight of topics	Bloom's Taxonomy						Total
			Remember	Understand	Apply	Analyze	Evaluate	Create	
Instructional design - General concepts	2	16.67%	2	2	0	0	0	0	4
Instructional design Theories	4	33.33%	2	2	1	0	1	0	6
Instructional design Process	2	16.67%	0	1	0	1	0	0	2
Instructional design Models – ADDIE Model	2	16.67%	0	0	1	1	1	1	4
Instructional design Models – ASSURE Model	2	16.67%	0	0	1	1	1	1	4
Total	12	100%	4	5	3	3	3	2	20

2.4.2 Questionnaire

The perspectives of the participants towards the experimental method used were evaluated by administering a questionnaire based on the Likert scale. It explored how students' perceptions of AI-driven tools and across lectures of Unit 4 affected their motivation and engagement. The original questionnaire contained 26 items organized into three themes: motivation, engagement, and perspective. After applying Lawshe's (1975) content validity ratio (CVR), 20 items were retained.

The first section collected demographic and other pertinent data from the students, while the second section focused on twenty specific items related to the study's objectives. A 5-point Likert scale was used to measure participants' agreement or disagreement with each statement. During the testing and measurement periods of this study, the researchers employed the Likert scale, which offers respondents the options of indicating their level of agreement as strongly agree, agree, neutral, disagree, and strongly disagree as shown in Table 2.

Table 2: The Likert scale options

Options	Ordinal	Extent of Average
Strongly Disagree	1st	1.00–1.80
Disagree	2nd	1.81–2.60
Neutral	3rd	2.61–3.40
Agree	4th	3.41–4.20
Strongly Agree	5th	4.21–5.00

2.4.3 Rubric

A comprehensive rubric, informed by existing research and tools (Crusan, 2010; Suhartoyo, 2017; Apriliadi and Suryaman, 2020; Zheng, Zhong and Gyasi, 2021), was developed to assess the critical thinking skills displayed in the essays of both groups (Table 3). This rubric evaluated various aspects of the writing, including the students' understanding of the ADDIE and ASSURE design models and their ability to articulate the key components and principles of each model. Additionally, the depth of critical thinking demonstrated in the essays was assessed, focusing on the students' analysis and evaluation of the strengths and weaknesses of each design model, as well as the creativity and originality in developing their own model. The rubric also considered how effectively they incorporated feedback to enhance their essays, including improvements in clarity, coherence, and argumentation. The clarity of expression and organization of ideas, along with the quality of writing mechanics, including grammar, punctuation, spelling, and adherence to academic writing conventions, was also evaluated. Finally, the overall impact of the essays, including the depth of insight, persuasiveness of arguments, and contribution to the understanding of the role of design models in educational technology, was considered in the assessment process.

Table 3: Essay Evaluation-Rubric

Criteria	Excellent (4)	Good (3)	Fair (2)	Poor (1)
Understanding of Design Models	Demonstrates thorough understanding of both models and articulates key components and principles clearly and accurately.	Demonstrates good understanding of both models and articulates key components and principles with minor inaccuracies or omissions.	Demonstrates basic understanding of both models but lacks clarity in articulating key components and principles.	Shows limited understanding of both models and fails to articulate key components and principles effectively.
Critical Thinking	Provides insightful analysis and evaluation of the strengths and weaknesses of each model, along with creative and original ideas for their own model.	Offers a solid analysis and evaluation of the strengths and weaknesses of each model, with some creativity and originality in their own model.	Presents a basic analysis and evaluation of the strengths and weaknesses of each model, with limited creativity in their own model.	Provides a superficial analysis and evaluation of the strengths and weaknesses of each model, with little to no creativity in their own model.
Integration of feedback	Effectively incorporates feedback from to enhance clarity, coherence, and argumentation, resulting in significant improvement in the essay.	Moderately incorporates feedback from to enhance clarity, coherence, and argumentation, resulting in some improvement in the essay.	Attempts to incorporate feedback from but with limited impact on clarity, coherence, and argumentation in the essay.	Does not effectively incorporate feedback from, with little to no improvement in clarity, coherence, and argumentation in the essay.
Clarity and Organization	Presents ideas clearly and logically, with well-structured paragraphs and smooth transitions between ideas.	Communicates ideas clearly, with mostly well-structured paragraphs and adequate transitions between ideas.	Conveys ideas with some clarity, but lacks consistent organization and may have disjointed paragraphs or transitions.	Expresses ideas unclearly, with poor organization and disjointed paragraphs or transitions.
Writing Quality	Demonstrates exemplary grammar, punctuation, spelling, and adherence to academic writing conventions throughout the essay.	Exhibits good grammar, punctuation, spelling, and adherence to academic writing conventions with minor errors.	Shows basic grammar, punctuation, spelling, and adherence to academic writing conventions, with some errors that do not impede understanding.	Displays poor grammar, punctuation, spelling, and adherence to academic writing conventions, hindering understanding of the essay.
Overall Impact	Provides an insightful and persuasive essay that contributes significantly to the understanding of the role of design models in educational technology.	Presents a solid essay that contributes to the understanding of the role of design models in educational technology.	Offers a basic essay that provides some insight into the role of design models in educational technology.	Delivers a superficial essay with little to no contribution to the understanding of the role of design models in educational technology.

2.5 AI-Driven Tools

In this study, sophisticated AI-driven tools were carefully embedded into the education system to enhance the learning environment. One of the major ways involves integrating Chatbots especially OpenAI's GPT-3 for Learning into Moodle LMS during teaching instructional design topics. These Chatbots helped students generate study plans and educational materials influenced by ADDIE and ASSURE instructional design models. Such powerful AI systems created lessons to be studied using them, assisted the making of studying materials that are easy to comprehend and supported students in brainstorming ideas about how AI can be used in education.

Another key aspect is the integration of gamified learning platforms, including Kahoot! These AI-driven gamification tools transform traditional learning methods by introducing engaging elements. Kahoot! was used to create interactive tests, discussions, and surveys to create a competitive and enjoyable atmosphere for

students. In addition, online help and support services are provided using tools such as Studiosity. Studiosity is an online platform that provides academic support services to students. It provides personal assistance in real time. Students have access to qualified tutors who can provide one-on-one help with homework, assignments, exam preparation and understanding course material. Additionally, Studiosity offers writing feedback services where students can submit their essays or written assignments for constructive feedback and improvement suggestions. This platform aims to enhance students' academic skills and performance by providing convenient and accessible support outside of traditional classroom settings.

All of these AI tools, along with a wide array of learning activities, multimedia resources, assignments, quizzes, and PowerPoint presentations, were conveniently accessible through the Moodle learning management system. Every student in the experimental group was able to access the Moodle learning management system using their unique account details (see Figure 2). In contrast, the control group received instruction on the same topics through conventional learning methods that involve lectures, readings, and conventional assessments. A screenshot depicting the course content is provided in Figure 3.

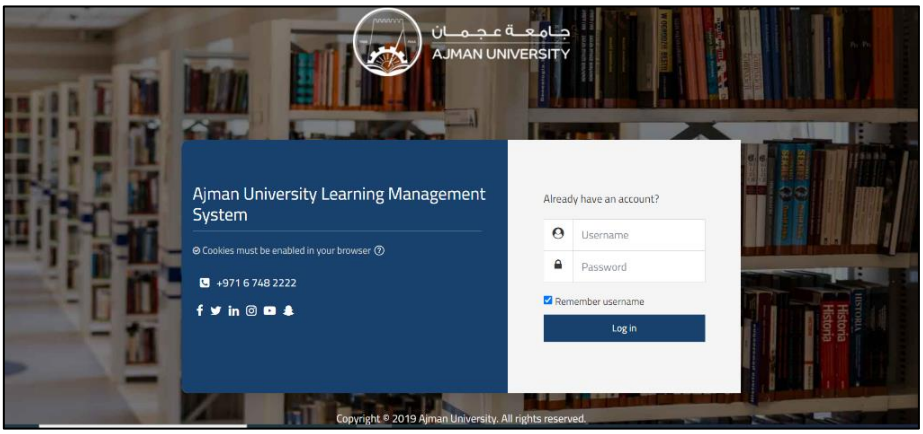

Figure 2: Moodle learning management system

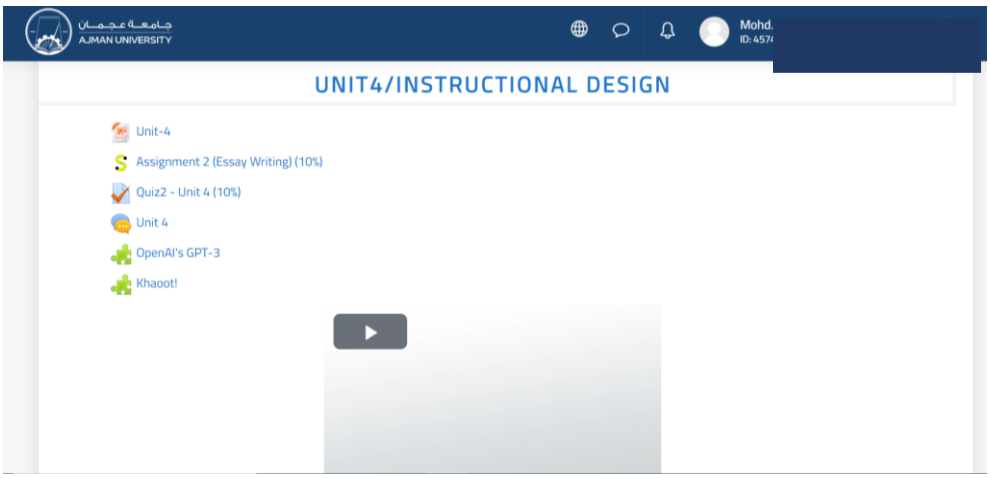

Figure 3: Course content screenshot

2.6 Statistical Analysis

Data analysis was conducted using the Statistical Package for Social Sciences (SPSS) package version (29.0), which generated descriptive statistics including frequency distributions, means, and standard deviations. To compare pre- and post-test results between the experimental and control groups, an independent samples t-test was employed. Before performing the t-test, the assumption of normality was verified to ensure the appropriateness of the analysis. Additionally, sociodemographic variables were examined; however, no significant differences were found between the two groups. Descriptive statistics were used to summarize the demographic characteristics of the participants, while inferential statistics were applied to assess the impact of AI-powered tools on both academic performance and students' perspectives. This approach provided a comprehensive

understanding of the differences between the experimental and control groups, offering insight into how AI integration influenced learning outcomes.

3. Results

3.1 Participants' Demographic Data

The study included 110 pre-service teachers, evenly split between the experimental and control groups, with 55 participants in each group, with an average age of 27.5 years. The majority of participants were female (70%), with 40 females in the experimental group and 37 in the control group, while male participants made up 30% of the sample. In terms of academic performance, 27.78% of participants had a CGPA between 2.5 and 2.99, 33.33% had a CGPA between 3.0 and 3.5, and 16.67% had a CGPA between 3.6 and 4.0. There was no statistically significant difference in the demographic characteristics of the participants in the two groups as shown in table 4 ($P > 0.05$) in terms of gender, age, and CGPA distributions. For instance, both groups were evenly split between males and females (40 females and 37 females, 15 males and 18 males), and the CGPA ranges were similarly distributed across both groups, with no significant deviations in academic background. Additionally, the age distribution, with the majority of participants falling between 27 and 31 years of age (60%), was balanced between the two groups.

Table 4: Participants' Demographic Data

		Group					
		Experimental		Control		Total	
		Count	N%	Count	N%	Count	N%
Gender	Female	40	36%	37	34%	77	70%
	Male	15	14%	18	16%	33	30%
CGPA	2.5-2.99	7	6%	8	7%	15	14%
	3.0-3.5	31	28%	32	29%	63	57%
	3.6-4.0	15	14%	17	15%	32	29%
Age	22-26	4	4%	8	7%	12	11%
	27-31	30	27%	36	33%	66	60%
	32-36	14	13%	12	11%	26	24%
	37-41	2	2%	4	4%	6	5%

3.2 Experimental and Control Group Equivalence

To assess group equivalence, normality assumptions were verified using the Shapiro-Wilk test prior to conducting an independent samples t-test. Both groups demonstrated approximately normal distributions of differences in the dependent variables, with p-values of 0.826 and 0.920, respectively, exceeding the 0.05 significance level.

An independent samples t-test revealed no significant differences between the experimental and control groups on pre-test measures as shown in table 5 ($p = 0.840$). This suggests that the groups were equivalent at the start of the study, minimizing the influence of confounding factors

Table 5: T-test of pre-test results: experimental and control groups

Group	N	Mean	Standard Deviation (SD)	T. value	Sig.	Sig. level
Control	55	12.54	1.85	0.217	0.840	Not Significant
Experimental	55	12.59	1.83			
Statistically significant at (p<0.05)						

3.3 Validity and Reliability of Instruments

The achievement test, perception questionnaire, and rubric underwent rigorous validation and reliability analysis, including content validation by ten subject matter experts, including professionals in Educational Psychology, Psychometrics and Educational Technology.

3.3.1 The validity and reliability of the achievement test

The content validity of the achievement test was established through expert agreement, as determined by Kendall's Coefficient of Concordance. The experts' agreement, as measured by Kendall's Coefficient of Concordance, was high and significant. The coefficient was 0.88 for cognitive levels or objectives and 0.78 for content areas, indicating strong coverage of both. This, along with the experts' positive assessment of face validity, provides strong evidence for the high content validity of the Achievement Test.

The K-R 20 coefficient was employed to evaluate the reliability of the Achievement Test. The results, as shown in Table 5, indicate a high reliability estimate of 0.887. A generally accepted threshold for high reliability is 0.8 or above (Tan, 2009). The value of 0.887 indicates that the test is consistent in measuring the same construct, which is a desirable property for a reliable assessment. This, in conjunction with a low standard error of measurement (SEM) of 0.723, supports the conclusion that the Achievement Test is highly reliable and can be used effectively.

K-R 20 = $(N / (N - 1)) * (1 - (\Sigma p * q) / \sigma^2)$

Table 5: Achievement Test estimate of reliability using Kuder-Richardson formula 20

Test-takers (Students)	No. of items (N)	Σp * q	σ²	rf	SEM
30	20	4.0025	4.383	0.887	0.723

3.3.2 The validity and reliability of the questionnaire

To validate the questionnaire instrument content validity, Lawshe's (1975) Content Validity Ratio (CVR) was employed. Lawshe (1975) suggested a minimum inter-judge agreement of 50%, using two indices: the CVR, which measures item-level agreement, and the Content Validity Index (CVI), which represents the overall agreement.

The CVR is calculated as follows:

CVR = (ne - N/2) / (N/2)

Where: ne is the number of panelists in agreement, N is the total number of panelists

A CVR index is considered acceptable based on the number of panelists. For ten judges, Lawshe's critical CVR is 0.62 or higher for an item to be retained (Lawshe's, 1975). The results of CVR analysis are listed in Table 6.

Table 6: CVR analysis

Theme	Items	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	Ne	CVR, N=10	Result
Motivation	1			1		1	1	1		1		5	0.5	Rejected
	2	1	1	1	1	1	1	1	1	1	1	10	1.00	Accepted
	3		1	1		1	1	1	1	1	1	8	0.80	Accepted
	4	1	1	1	1	1	1	1	1	1	1	10	1.00	Accepted
	5			1			1	1	1	1		5	0.50	Rejected
	6	1	1	1	1	1	1	1	1	1	1	10	1.00	Accepted
	7	1		1	1	1	1	1	1	1	1	9	0.90	Accepted
	8	1	1	1	1	1	1	1	1	1	1	10	1.00	Accepted
Engagement	9		1	1	1	1	1	1	1	1	1	9	0.90	Accepted
	10	1	1	1	1	1	1	1	1	1	1	10	1.00	Accepted
	11					1			1	1		3	0.30	Rejected

Theme	Items	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	Ne	CVR, N=10	Result
	12	1	1	1	1		1	1		1		7	0.70	Accepted
	13	1	1	1			1	1	1	1	1	8	0.80	Accepted
	14	1	1	1	1	1		1			1	7	0.70	Accepted
	15		1		1	1	1	1	1	1	1	8	0.80	Accepted
	16	1	1	1	1	1	1	1	1	1	1	10	1.00	Accepted
Perspective	17		1	1	1		1	1	1	1		7	0.70	Accepted
	18		1				1		1		1	4	0.40	Rejected
	19	1	1	1	1	1	1	1	1	1	1	10	1.00	Accepted
	20	1	1	1	1	1	1	1	1	1	1	10	1.00	Accepted
	21		1	1	1	1	1	1	1	1		8	0.80	Accepted
	22	1	1	1	1	1	1	1	1	1		9	0.90	Accepted
	23	1	1	1	1	1	1	1	1	1	1	10	1.00	Accepted
	24		1	1	1	1	1	1	1	1		8	0.80	Accepted
	25	1	1	1	1	1	1	1	1	1		9	0.90	Accepted
	26				1	1			1			3	0.30	Rejected
												CVI	0.796154	

CVR assesses individual item validity, while CVI evaluates overall expert agreement on the instrument

Based on expert evaluations (N=10), a minimum CVR value of 0.62 was established at a significance level of p = 0.05. Items meeting or exceeding this threshold were retained, while others were discarded. As shown in Table 6, 20 of the 26 items met the CVR criterion and were retained, while 6 items were rejected.

The high agreement rating from all experts, evidenced by the CVI value of 0.796, indicates strong content validity. This suggests that the questionnaire instrument effectively measures the intended construct. The reliability of the internal consistency of the questionnaire was tested using Cronbach's alpha, yielding a result of 0.883, indicating good internal consistency.

3.3.3 The validity and reliability of the rubric

To validate the rubric, subject matter experts evaluated its indicators using a 5-point Likert scale assessing relevance, clarity, and overall satisfaction. Experts were also invited to provide feedback for improvement. Aiken's V was used to measure inter-rater agreement, with values above 0.75 deemed acceptable.

Table 7: Rubric's Content validity results

Variable	Mean	SD	Aiken's V
Relevance	4.2	0.74	0.80
Clarity	4.1	0.94	0.77
Overall satisfaction	4.4	0.66	0.85

As shown in Table 7, the experts agreed on the rubric's relevance, clarity, and overall satisfaction, with Aiken's V values consistently exceeding 0.75. This indicates strong content validity for the instrument.

Inter-rater reliability was assessed using weighted Cohen's kappa to evaluate the consistency of scoring between two raters. Two faculty members independently rated the essays of 15 students from the study sample, employing a 4-point rubric. The results shown in Table 8 indicate that there is substantial agreement between the two raters for most of the criteria, with moderate agreement for clarity, organization, and integration of feedback. This suggests that the rubric is reliable for assessing these aspects of student work.

Table 8: Rubric's reliability results

Criteria	Agreement Percentage (%)	Weighted Kappa	Std. Error	z	Sig.	Interpretation
Critical Thinking	73%	0.674	0.144	3.294	0.001	Substantial Agreement
Understanding of Design Models	80%	0.685	0.130	3.389	0.001	Substantial Agreement
Writing Quality	60%	0.451	0.140	2.417	0.016	Moderate Agreement
Clarity and Organization	67%	0.599	0.145	3.364	0.001	Moderate Agreement
Integration of feedback	73%	0.524	0.187	2.324	0.020	Moderate Agreement
Overall Impact	87%	0.746	0.170	3.786	0.000	Substantial Agreement

3.4 Study Results Related to Q1

The main focus of question 1 of the study was to investigate how does AI influence academic performance in the Educational Technology course, as measured by achievement tests? To assess this, the mean student scores in a summative assessment test were calculated and compared between the experimental group and the control group. A t-test for two independent samples was also employed to determine the difference between the mean student scores in the two groups (Tables 9 and 10).

Table 9: Average and SD of post-test results

Group	N	Mean	SD
Experimental	55	18.32	1.21
Control	55	15.31	1.53

According to Table 9, the test scores of the experimental group students who were taught using the AI-driven tools approach (M=18.32, SD=1.21) were different from the control group students who were taught using the traditional approach (M=15.31, SD=1.53).

Table 10: The independent sample t-test of post-test

	Levene's Test for Equality of Variances		t-test			
	F	**Sig.**	**t**	**df**	**Sig.**	**Mean Difference**
Equal variances assumed	2.732	.080	10.356	105	0.000	3.01221
Equal variances not assumed			10.343	94.080	0.000	94.080

Based on the results in Table 10, the p-value (0.000) is less than 0.05, indicating that there are significant differences between the two groups in terms of their comprehension of unit 4 topics discussed during the lectures..

3.5 Study Results Related to Q2

The second question of this study aimed to determine how the use of AI tools contributes to enhancing the critical thinking ability among pre-service student teachers. This was done through group assignment of writing an essay whereby the students would express their views about ADDIE and ASSURE design models and thereafter come up with another model. The experimental group was provided a Studiosity tool and ChatGPT for both intervention and formative feedback as they wrote, while the control group wrote their essay independently without any form of external aid.

Table 11: Rubric Analysis Results

Criteria	N	Experimental Group		Control Group	
		Mean	SD	Mean	SD
Critical Thinking	55	3.56	0.71	3.03	1.03
Understanding of Design Models	55	3.65	0.67	3.42	0.88
Writing Quality	55	3.49	0.79	2.91	1.08
Clarity and Organization	55	3.67	0.67	3.25	1.00
Overall Impact	55	3.44	0.90	3.11	1.12

From the above Table 11, it is clear that the experimental group, which was implemented using Studiosity and ChatGPT tools to boost and give feedback while writing essays, demonstrated higher inclinations in critical thinking than the control group (experimental group: M = 3.56, SD = 0.71; control group: M = 3.03, SD = 1.03). This was evident in their progress, which reflected their taking up of constructive criticism towards their ability to deeply analyze and evaluate with nuanced and to be more creative in coming up with their own design model.

Furthermore, the experimental group recorded more comprehensive knowledge of the ADDIE and ASSURE design models as opposed to the control group (experimental group: M = 3.65, SD = 0.67; control group: M = 3.42, SD = 0.88). Although both groups showed reasonable critical thinking ability, the essays of the experimental group generally had a higher quality with regard to clarity, organization, and writing mechanics (Experimental group: M = 3.49; Control group: M = 2.91).

3.6 Study Results Related to Q3

The third research question sought to establish an answer on differences in motivation levels of the students in the experimental and control groups. In the light of the question, on the part of the participants, average scores and standard deviations have been computed, which are reproduced below in Table 12 and consist of the participant responses to the statements (S1 – S6) of the questionnaire related to motivation.

As shown by Table 12, the integration of AI-driven tools into the environment of education positively affects students' motivation to learn topic (4) of the educational technology course, with a mean score (M) of 4.51 and a standard deviation (SD) of 1.03. A high level of consensus was also observed in statement S2, which shows that AI methodologies provide new opportunities among learners for experiences in personalized learning. The statement, "Using AI-driven tools in Educational Technology course enhances my motivation to explore innovative teaching methods," acquired the second-highest degree of agreement among participants, having a mean score of 4.75. Statement 5 came third in its ranking by degree of agreement to this statement, with an average score of 4.61 and high consensus. Furthermore, statements S6 and S4 also received a "very high agreement" ranking among participants.

Table 12: Results of the statistical analysis of Motivation

S. No.	Statements	Mean	SD	Ordinal	Description
S2	I feel more motivated to engage with AI-driven methodologies because they offer new opportunities for personalized learning experiences.	4.78	0.760	1	Strongly Agree
S1	Using AI-driven tools in Educational Technology course enhances my motivation to explore innovative teaching methods.	4.75	0.770	2	Strongly Agree
S5	AI-driven tools in Educational Technology course stimulate my interest in understanding and applying emerging technologies in education.	4.61	1.022	3	Strongly Agree
S6	AI-driven tools in Educational Technology course increase my motivation to adapt to changing educational landscapes and embrace technological advancements.	4.56	1.157	4	Strongly Agree
S4	Learning about AI applications in educational settings excites me and encourages me to explore new teaching strategies.	4.31	1.348	5	Strongly Agree

S. No.	Statements	Mean	SD	Ordinal	Description
S3	The integration of AI-driven tools in my Educational Technology course increases my enthusiasm for learning and teaching.	4.06	1.145	6	Agree
Average		4.51	1.034		Strongly Agree

3.7 Study Results Related to Q4

Research question four aimed to determine whether the level of engagement in the Educational Technology course significantly varied among those students exposed to AI-driven tools in course instruction and those that had exposure to students who learned through traditional modes of teaching. In connection to these, average scores and standard deviations have been calculated by the researchers to address this question, and it is presented in Table 13 along with the participants' response to the respective statements (S7-S12) of the questionnaire on engagement.

Data in Table 13 show that the mean score for all statements related to the engagement (S7-S12) was 4.46 with a standard deviation of 0.90. This result does lead to the conclusion that integrating AI-driven tools into the educational environment managed to yield a very high level of learner engagement from the experimental group. It is interesting to note that statement S9 scored the highest average score of consensus at 4.89 among participants, which depicts a very high level of agreement. Similarly, S10 had a mean score for the second most, which has a strong rating, with 4.83. On the other hand, S12 obtained the third highest mean score of 4.78, hence indicating that the statement was agreed upon at a very high rate.

Despite this, the lowest average score of 3.75 was obtained for statement S11, which still indicates a level of agreement among experimental group students. Overall, these findings suggest that integrating AI-driven tools into the educational environment positively impacts engagement levels among learners in the experimental group.

Table 13: Results of the statistical analysis of Engagement

No.	Statements	Mean	SD	Ordinal	Description
S9	I find that using AI-driven methodologies in my learning increases student motivation and interest in course materials.	4.89	0.523	1	Strongly Agree
S10	AI-driven tools provide students with immediate feedback, which enhances their engagement and understanding of course concepts.	4.83	0.697	2	Strongly Agree
S12	AI-driven educational tools provide opportunities for differentiated instruction, catering to diverse learning preferences and increasing student engagement.	4.78	0.681	3	Strongly Agree
S7	The incorporation of AI-driven tools in my Educational Technology course promotes a sense of curiosity and exploration among students.	4.50	1.108	4	Strongly Agree
S8	AI-driven educational tools facilitate active learning experiences that encourage students to take ownership of their learning process.	4.03	1.108	5	Agree
S11	Students' excitement and enthusiasm for learning are heightened when AI-driven tools are integrated into classroom activities.	3.75	1.296	6	Agree
Average		4.46	0.902		Strongly Agree

3.8 Study Results Related to Q5

The fifth research question of the study aimed to explore the perspectives of pre-service student-teachers regarding the use of AI in educational environments, particularly in the context of Educational Technology courses. To address this question, the researchers calculated the average scores and standard deviations, and Table 14 presents the participants' responses to statements (S13-S20) of the questionnaire.

Table 14: Results of the statistical analysis of students' perspectives

No.	Statements	Mean	SD	Ordinal	Description
S14	AI-driven methodologies offer innovative solutions to address the diverse learning needs of students in Educational Technology course.	4.78	0.681	1	Strongly Agree
S19	The integration of AI-driven methodologies in Educational Technology course fosters a culture of innovation and creativity in teaching and learning practices.	4.53	0.971	2	Strongly Agree
S17	The integration of AI in Educational Technology course empowers educators to deliver personalized and adaptive instruction.	4.44	1.182	3	Strongly Agree
S16	AI-driven technologies have the potential to transform traditional teaching methods into dynamic and engaging learning experiences in Educational Technology course.	4.33	1.265	4	Strongly Agree
S15	Incorporating AI-driven tools in Educational Technology course aligns with the evolving needs of 21st-century learners.	4.06	1.145	5	Agree
S13	The integration of AI-driven tools in Educational Technology course enhances student learning outcomes.	4.03	1.108	6	Agree
S20	Leveraging AI in Educational Technology course promotes the development of future-ready skills among students, preparing them for success in a digital age.	4.00	0.793	7	Agree
S18	AI-driven technologies in Educational Technology course enhance accessibility and inclusivity, ensuring equitable learning opportunities for all students.	3.78	0.797	8	Agree
Average		4.24	0.992		Strongly Agree

Results in Table 14 further indicate that the attitude of the pre-service student teachers (S13-S20) on the integration of the AI-driven tools within the educational environment was generally positive. The average mean score across all statements was 4.24, indicating a strong overall agreement among participants. Statements S14 and S19, in particular, had mean scores of 4.78 and 4.53, respectively, with high consensus that the AI-driven methodologies do provide innovations in meeting the different needs of learners, which leads to innovation and creativity in practices of teaching and learning. In addition, it means that a mean score of 4.44 and 4.33 on the statements S17 and S16, respectively, indicated a very strong agreement that would facilitate educators to empower students in personalized and adaptive delivery of instruction and transformation from static traditional teaching to dynamic and engaging learning experiences. Statements S15, S13, and S20 also received positive mean scores ranging from 4.06 to 4.00, demonstrating agreement that incorporating AI-driven tools aligns with the evolving needs of 21st-century learners, enhances student learning outcomes, and promotes the development of future-ready skills among students. While statement S18 received a slightly lower mean score of 3.78, indicating agreement that AI-driven technologies enhance accessibility and inclusivity, the overall analysis suggests a favorable perspective towards the integration of AI-driven tools in Educational Technology courses among pre-service student-teachers.

3.9 Study Results Related to Q6

The study investigated potential differences in student perspective levels based on gender, utilizing a T-test to analyze the significance of these differences, as outlined in Table 15. The results revealed that the observed p-value (0.403) exceeded the predetermined significance level of 0.05. Thus, the test did not reach significance at the 0.05 level, indicating no significant disparity in perspective levels based on gender among participants in the experimental group.

Table 15: Means and standard deviations of the student answers based on gender.

Gender	N	Mean	SD	T	Sig.	Sig. level
Female	40	4.20	.320	1.611	0.403	Not Significant
Male	15	4.36	.279			

4. Discussion

In this study, six research questions related to integrating AI-driven tools in the educational environment were addressed with a particular focus on educational technology course. The discussion will majorly delve on the key findings and ramifications for every research question.

Research Question 1: How does AI influence academic performance in the Educational Technology course, as measured by achievement tests? In our analysis, we found that there was a statistically significant difference between the experimental group, who had been taught through the AI-driven tools, and the control group that had been taught using traditional methods in relation to its comprehension of the topics presented in Unit 4. In other words, AI in the educational setting betters the learning, assimilation, and retention of course materials by the students. This result goes hand in hand with that obtained by other authors (Zhai et al., 2021; Ijaz, Bogdanovych and Trescaket, 2017; Ocaña-Fernández, Valenzuela-Fernández and Garro-Aburto, 2019).

For Research Question 2: Does the effect of influence AI integration improve the critical thinking skills of preservice student-teachers? It was found that the experimental group, while using Studiosity and ChatGPT for enhancement and feedback during the process of writing essays, showed improved performance in critical thinking compared to the control group. Furthermore, the use of AI tools not only benefited critical thinking development but also led to overall improvements in writing proficiency. Moreover, while both the experimental and control groups contributed valuable information in regard to the role of the design model in educational technology, the experimental group made clearer the articulation of ideas at this level and contributed more useful information to the perception of the relationship between AI integration and the advancement of critical skills in this discipline. Taken together, therefore, the results point toward a positive impact that AI, being brought through StudioSty and ChatGPT, has on the development of critical thinking skills amongst pre-service student-teachers in Educational Technology. This finding came in line with the study by Lacity and Willcocks (2017), where the experimental group seemed to develop a more improved sense of developing more comprehensive models. They related AI integration to an improvement in skills in critical thinking.

Question 3: Compare the motivation levels between the students exposed to the AI-driven tools with the ones exposed to traditional means of teaching. Such revealed results by our analysis suggested that the integration of AI-driven tools within the education environment bears a positive impact on the motivation of the students, which is seen through the high rate of agreement in relation to the statements on how the enhancement of motivation and interest towards the course material is done. This result is consistent with the prior studies (Flogie and Aberšek, 2015; du Boulay, 2016; Ling, 2023).

With regard to Research Question 4, which aimed to establish differences in the level of engagement between the students exposed to AI-driven tools and those who are exposed to traditional methods of instructions, this study found out that there are very high levels of engagement in the experimental group. This finding is similar to Zhang and Aslan (2021) in the sense that the statements made about immediate feedback, differentiated instruction, and increased motivation had very high levels of agreement, indicating the positive impacts that AI integration has on students' motivation levels towards technology.

This then informs Research Question 5, which seeks to determine the perception of the use of AI in educational environments by pre-service student-teachers. Generally, the attitudes reflected toward the integration of AI tools and methods with the help of mean scores from Likert analysis are positive. Strong agreement was found for the statements that underlined innovative solutions, personalization in learning, and transformation by the integration of AI. This result aligns with the more recent findings (Flogie and Aberšek, 2015; du Boulay, 2016; Lacity and Willcocks, 2017; Zhai et al., 2021). Finally, research question 6 sought to establish whether there exists any statistical difference between the perspective scores with regard to the gender of the students.

In the experimental group, no differences in the level of perspective were identified between the sexes. This finding is, however, in contrast to one reported in the study by Kuleto et al. (2021), who found the overall mean gender differences for the factors of AI anxiety and perceived enjoyment to be significant, with females scoring high compared to males in AI anxiety. In summary, this study re-measures the positive role that integration of

AI can play across the dimensions of the academic performance, critical thinking skills, motivation, engagement, and perspectives of the pre-service student-teachers' educational experience.

Such findings reflect great impacts on the design and implementation of educational technology courses, thus mirroring the potential opportunities for the use of AI-driven tools that bring better outcomes in teaching and learning.

5. Limitations

However, the strong research methodology exhibited by this study may have some potential limitations, which need to be addressed by future research. First, sample size in the study can be a cause of not generalizing the findings. For this, the future scope of research may include larger and more diversified samples, which may allow a wider understanding of the spectrum with regard to the impact of AI integration within the educational environment, so as to mitigate this particular limitation. This may limit the generalization of results to other settings, given the exact educational context of this study. In future studies, the effects of AI integration could be studied in many other educational environments, wherein more general results may be brought into light.

Secondly, the findings may be influenced by the specific AI tools used in this study, such as ChatGPT and Studiosity. While these tools offer valuable insights into AI's impact on student performance, motivation, and critical thinking, they may not fully represent the range of AI applications in education. This limitation suggests that further research is needed to explore the effects of different AI-driven tools in various educational contexts to better understand their broader implications.

In addition, by virtue of self-report measures, the variables of motivation, engagement, and assessment of perspective may all be impacted by potential bias.

This has, therefore, made the use of self-reported data in this study. For that reason, the following researches are recommended: they need to come up with the objective measures or observation data while still using the self-reports to enhance the reliability of the studies. These limitations can be addressed in future research programs to give a sturdy understanding of the implication of AI integration in the educational setup.

6. Conclusion

This study hence gives insight into the effect of integrating AI tools in the educational environment. Six research questions have been expounded upon, and through that process, many findings have emerged regarding the role of AI in education. This will put in consideration the fact that AI inclusion works for better academic performance, as clear differences in the effects of comprehension were established between those taught through AI-driven tools and the other category of traditional methods. This underlines the potential of AI to enhance the acquisition and retention of class material for students.

The other key aspect of the study that stands out is how integration of AI brings about improvement in the critical thinking skills of the student-teachers. This suggests that students in the experimental group using Studiosity and ChatGPT for improvement and feedback in essay writing held much better skills in critical thinking over the control group. This suggests that AI-driven tools contribute to the development of students' analytical and evaluative abilities.

Importantly, the results of the study identify that the integration of AI-driven tools and techniques in the educational setup helps increase students' motivation and involvement in the learning process. Students using AI-driven tools, of course, were motivated and interested in course materials and showed high results of engagement with the learning process. This, in turn, is suggestive of the idea that its integration bears great potential in creating much more dynamic and interactive learning experiences for students through the application of AI. The current study is an example in which a positive attitude toward using AI in education is shown by the pre-service student-teachers. They totally agreed that AI integration would provide innovative solutions, personalized learning experiences, and transformative potential, hence indicating readiness to adapt and progress in teaching practices with such technological advancements in the future.

Lastly, the gender differences in perspective level did not show a varied result between the experimental group participants and their two genders. This might further suggest that the integration of AI will be able to help students indifferent to their gender. This would underline all of these results from this study to be important in the positive impact on the integration of AI in the educational experience. Learning environments become the most powerful and motivating ones that could have relevance for the learners' contexts of the developed and adapted learning environments of the learners with AI-driven tools. Thus, since technology is on a continuous

rise in such a highly digitalized world, the place of AI in education becomes highly necessary. It includes preparing students for the 21st-century world.

The findings of this study underscore the transformative potential of AI in education. Educators and policymakers must proactively embrace AI integration, ensuring ethical and equitable implementation. By investing in AI infrastructure, professional development, and research, we can harness the power of AI to enhance teaching and learning, improve student outcomes, and prepare learners for an AI-driven future.

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References

Adair, A., 2023. Teaching and Learning with AI: How Artificial Intelligence is Transforming the Future of Education. XRDS: Crossroads, *The ACM Magazine for Students*, 29(3), 7-9.

Alam, A., 2021. Possibilities and apprehensions in the landscape of artificial intelligence in education. In 2021 International Conference on Computational Intelligence and Computing Applications (ICCICA), Nagpur, India, 2021, pp. 1-8, https://doi.org/10.1109/ICCICA52458.2021.9697272.

Alemán de la Garza, L.; Gómez Zermeño, M.; Mochizuki, Y.; Bruillard, E.; Anichini, A.; Antal, P.; Beaune, A.; Bruillard, E.; Burke, D.; Henrique Cacique Braga, P.; et al., 2019. Rethinking Pedagogy. Exploring the Potential of Digital Technology in Achieving Quality Education; UNESCO MGIEP: New Delhi, India.

Annamalai, N., Eltahir, M. E., Zyoud, S. H., Soundrarajan, D., Zakarneh, B., & Al Salhi, N. R., 2023. Exploring English language learning via Chabot: A case study from a self determination theory perspective. *Computers and Education: Artificial Intelligence*, 100148. https://doi.org/10.1016/j.caeai.2023.100148

Apriliadi, F. and Suryaman, M., 2020. Development of scoring rubric of writing literacy criticism based on critical thinking skills for senior high school student in Indonesia. International Journal of Research and Review, 7(4), pp.99-107.

Bahja, M., Kuhail, M. A., & Hammad, R., 2022. Embracing technological change in higher education. In IntechOpen eBooks. https://doi.org/10.5772/intechopen.100431

Baker T, Smith L, Anissa N (2019), Exploring the Future of Artificial Intelligence in Schools and Colleges [pdf] NESTA. Available at: <https://media.nesta.org.uk/documents/Future_of_AI_and_education_v5_WEB.pdf> [Accessed 10 September 2024].

Butakor, P. K., 2023. Exploring Pre-Service Teachers' Beliefs About the Role of Artificial Intelligence in Higher Education in Ghana. *International Journal of Innovative Technologies in Social Science*, 3(39). https://doi.org/10.31435/rsglobal_ijitss/30092023/8057

Chen, L., Chen, P., & Lin, Z., 2020. Artificial Intelligence in Education: a review. *IEEE Access*, 8, 75264–75278. https://doi.org/10.1109/access.2020.2988510

Christopoulos, A., Kajasilta, H., Salakoski, T., & Laakso, M.-J., 2020. Limits and Virtues of Educational Technology in Elementary School Mathematics. *Journal of Educational Technology Systems*, 49(1), 59-81. https://doi.org/10.1177/0047239520908838

Crusan, D., 2010. Assessment in the second language writing classroom. University of Michigan Press.

Cruz-Jesus, F., Castelli, M., Oliveira, T., Mendes, R. M. N., Nunes, C., Sa-Velho, M., & Rosa-Louro, A., 2020. Using artificial intelligence methods to assess academic achievement in public high schools of a European Union country. *Heliyon*, 6(6), e04081. https://doi.org/10.1016/j.heliyon.2020.e04081

De La Higuera, C., 2019. *A report about education, training teachers and learning artificial intelligence: Overview of key issues.* http://cdlh7.free.fr/UNESCO/Teaching_AI-cdlh.pdf

du Boulay, B., 2016. Artificial intelligence as an effective classroom assistant. *IEEE Intelligent Systems*, 31(6), 76–81. https://doi.org/10.1109/mis.2016.93

Eggert, Katharina., 2021. How artificial intelligence will shape universities of tomorrow. In *2021 International Conference*, p. 50. HTWG Konstanz University of Applied Sciences, Germany.

Ertel, Wolfgang., 2018. *Introduction to artificial intelligence*. (2nd ed.). Springer. https://doi.org/10.1007/978-3-319-58487-4

Fetzer, J.H., 1990. What is Artificial Intelligence? In: *Artificial Intelligence: Its Scope and Limits. Studies in Cognitive Systems*, vol 4. Springer, Dordrecht. https://doi.org/10.1007/978-94-009-1900-6_1

Flogie, A., & Aberšek, B., 2015. Transdisciplinary approach of science, technology, engineering and mathematics education. *Journal of Baltic Science Education*, 14(6), 779–790. https://doi.org/10.33225/jbse/15.14.779.

George B, Wooden O., 2023. Managing the Strategic Transformation of Higher Education through Artificial Intelligence. *Administrative Sciences*, 13(9):196. https://doi.org/10.3390/admsci13090196

Gupta, R., & Bhatia, S., 2019. Artificial intelligence: A boon to the education industry. International *Journal of Computer Applications*, 177(33), 18-21.

IBM, 2023. *Understanding the different types of artificial intelligence*. https://www.ibm.com/blog/understanding-the-different-types-of-artificial-intelligence/l.

Ijaz, K., Bogdanovych, A., & Trescak, T., 2017. Virtual worlds vs books and videos in history education. *Interactive Learning Environments*, 25(7), 904-929. https://doi.org/10.1080/10494820.2016.1225099

Kadaruddin, K., 2023. Empowering Education through Generative AI: Innovative Instructional Strategies for Tomorrow's Learners. *International Journal of Business, Law, and Education*, 4(2), 618 - 625. https://doi.org/10.56442/ijble.v4i2.215

Kuleto, V., Ilić, M., Dumangiu, M., Ranković, M., Martins, O.M., Păun, D. and Mihoreanu, L., 2021. Exploring opportunities and challenges of artificial intelligence and machine learning in higher education institutions. Sustainability, 13(18), p.10424.

Kulik, J.A. and Fletcher, J.D., 2016. Effectiveness of intelligent tutoring systems: a meta-analytic review. Review of educational research, 86(1), pp.42-78.

Lacity, M., & Willcocks, L. P., 2017. *Robotic Process Automation and Risk Mitigation: The Definitive Guide*, SB Publishing, Ashford, UK.

Lawshe, C. H., 1975. A quantitative approach to content validity. *Pers. Psychol*. 28, 563–575. doi: 10.1111/j.1744-6570.1975.tb01393.x

Ling, W., 2023. Artificial intelligence in language instruction: impact on English learning achievement, L2 motivation, and self-regulated learning. *Frontiers in Psychology*, 14. https://doi.org/10.3389/fpsyg.2023.1261955

Loeckx, J., 2016. Blurring Boundaries in Education: Context and Impact of MOOCs. *The International Review of Research in Open and Distributed Learning*, 17(3), 92–121. https://doi.org/10.19173/irrodl.v17i3.2395

Luckin, Rose; Luckin, Wayne; Griffiths, Mark and Forcier, Laurie B, 2016. *Intelligence Unleashed: An argument for AI in Education*. Open Ideas; Pearson Education, London.

McCarthy, J., 2007. *What is artificial intelligence*. http://jmc.stanford.edu/artificial-intelligence/what-is-ai/index.html

Ocaña-Fernández, Y., Valenzuela-Fernández, L. A., & Garro-Aburto, L. L., 2019. Inteligencia artificial y sus implicaciones en la educación superior. *Propósitos Y Representaciones*, 7(2). https://doi.org/10.20511/pyr2019.v7n2.274

Pedró, F., Subosa, M., Rivas, A., and Valverde, P., 2019. *Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development*. Paris: UNESCO.

Qushem, U.B.; Christopoulos, A.; Oyelere, S.S.; Ogata, H.; Laakso, M.-J., 2021. Multimodal Technologies in Precision Education: Providing New Opportunities or Adding More Challenges? *Educ. Sci*. 11(7), 338. https://doi.org/10.3390/educsci11070338

Salama, R., & Hinton, T., 2023. Online higher education: current landscape and future trends. Journal of Further and Higher Education, 47(7), 913–924. https://doi.org/10.1080/0309877x.2023.2200136

Seldon, A., & Abidoye, O., 2018. *The Fourth Education Revolution*, University of Buckingham Press, London, UK.

Suhartoyo, E., 2017, October. The importance of critical thinking competence: An investigation of students' writing experiences. In Proceedings at International Seminar on Language, Education, and Culture (ISoLEC) (pp. 2598-0653).

Tan, Ş., 2009. Misuses of KR-20 and Cronbach's alpha reliability coefficients. *Educ. and Sci*., 34, 152, 101-112.

Trisoni, R., Ardiani, I., Herawati, S., Mudinillah, A., Maimori, R., Khairat, A., David, D., & Nazliati, N., 2023. The effect of artificial intelligence in improving student achievement in high schools. In *Advances in social science, education and humanities research* (pp. 546–557). https://doi.org/10.2991/978-2-38476-142-5_50

Zawacki-Richter, O., Marín, V.I., Bond, M. and Gouverneur, F., 2019. Systematic review of research on artificial intelligence applications in higher education–where are the educators? *International Journal of Educational Technology in Higher Education*, 16(1), pp.1-27.

Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., ... & Li, Y., 2021. A Review of Artificial Intelligence (AI) in Education from 2010 to 2020. *Complexity*, 2021, 1-18. https://doi.org/10.1155/2021/8812542

Zhang, C., Schießl, J., Plößl, L., Hofmann, F., & Gläser-Zikuda, M., 2023. Acceptance of artificial intelligence among pre-service teachers: a multigroup analysis. *International Journal of Educational Technology in Higher Education*, 20(1), 49. https://doi.org/10.1186/s41239-023-00420-7

Zhang, K., & Aslan, A. B., 2021. AI technologies for education: Recent research & future directions. *Computers and Education Artificial Intelligence*, 2, 100025. https://doi.org/10.1016/j.caeai.2021.100025

Zheng, L., Niu, J., Zhong, L., & Gyasi, J. F., 2021. The effectiveness of artificial intelligence on learning achievement and learning perception: A meta-analysis. *Interactive Learning Environments*, 31(9), 5650–5664. https://doi.org/10.1080/10494820.2021.2015693

