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The Impact of Artificial Intelligence Applications on Developing Levels of Cognitive Depth of Information among Postgraduate Students

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Abstract. This study explores the unique impact of artificial intelligence (AI) platforms—specifically ChatGPT—on developing cognitive depth among graduate students, distinguishing itself from previous research by focusing not only on academic achievement but also on higher-order thinking skills such as analysis, synthesis, and evaluation. A quasi-experimental method was employed involving two experimental groups (n = 35) from the College of Education at King Khalid University. The first group (n = 17) received instruction through AI platforms, while the second group (n = 18) used traditional methods via the Blackboard system. Pre- and post-tests were conducted to measure cognitive depth using a validated instrument with a reliability coefficient of 0.89. Findings revealed statistically significant differences in favor of the AI group, who showed marked improvement in levels of recall, application, strategic thinking, and extended reasoning. The AI platforms' features—such as personalized content, instant feedback, and interactive interfaces—contributed to enhanced critical and creative thinking and a more engaged learning experience. This research demonstrates the effectiveness of AI in deepening students' understanding and recommends its integration into university curricula. It also suggests faculty training and the development of AI-based assessment tools to further support digital-age learning needs.

Keywords: electronic platforms; artificial intelligence; depth of knowledge

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1. Introduction

The rapid advancement of artificial intelligence (AI) technologies has brought about significant transformations in the field of education, especially in higher education. AI platforms such as ChatGPT, machine learning (ML) systems, and adaptive learning technologies are increasingly integrated into academic environments to personalize instruction, enhance digital learning, and support students' abilities to analyze, evaluate, and create knowledge. Numerous studies have emphasized the role of AI in boosting academic achievement and improving self-directed learning by offering interactive and intelligent tools that help students engage with content more deeply (Lu, 2025; Hwang & Chang, 2024).

However, while these technological advancements are promising, there remains a gap in the literature regarding their actual effectiveness in developing cognitive depth, particularly at the postgraduate level. Most prior research has focused on surface-level outcomes, such as test performance or engagement, but has not thoroughly examined how AI tools affect students' ability to process information critically, apply strategic thinking, or develop extended reasoning. Moreover, concerns have been raised that over-reliance on AI may hinder students' intellectual independence, encouraging superficial learning instead of deep comprehension (Capella, 2025; Al-Rashidi & Al-Farani, 2024).

Rapid advances in artificial intelligence (AI) have revolutionized teaching and learning methods within higher education institutions. AI applications such as intelligent recommendation systems, adaptive learning, and virtual assistants are powerful tools to support student learning, contributing to improved academic performance and providing more personalized learning environments that respond to their individual needs (Zawacki-Richter et al., 2024). However, the impact of these applications on students' cognitive depth remains a matter of academic debate, with questions being raised about whether they enhance critical and analytical thinking or limit intellectual independence and the ability to process information deeply. Cognitive depth is an essential component of university learning, referring to students' ability to critically analyze and interpret information, make deep cognitive connections, and generate innovative ideas based on prior knowledge (Hwang & Chang, 2024).

Cognitive depth is one of the essential goals of university education, as it refers to students' ability to understand knowledge in depth, reshape it critically, and relate it to multiple contexts (Abu Muqaddam, 2024). Despite the tremendous developments in the field of educational technology, there remains a challenge in how to enhance cognitive depth in a way that improves the ability to think analytically and reason cognitively, especially considering the spread of artificial intelligence technologies and applications that may contribute to facilitating access to information but not necessarily deepening its understanding (Hamed, 2024).

Through the OpenAI platform, the ChatGPT application can be used to help students organize their thoughts and generate new creative ideas and plans and to enhance and develop their innovation and entrepreneurship skills. Students

can also collaborate with the teacher to discuss and analyze ideas and information obtained from artificial intelligence platforms and then obtain deep and useful ideas and information that can contribute significantly to producing entrepreneurial ideas that serve society. The learner can also use ChatGPT to create an article on a specific topic, design a presentation followed by an audio recording and modify it, generate illustrative images, design symbolic images on a specific topic, design integrated electronic lessons, and many other uses of modern artificial intelligence platforms; therefore, it can be said that the ChatGPT platform is a platform for preparing individuals for future professions.

Concerning this, the study of Halaweh (2023) concluded that the ChatGPT platform can be used to evaluate the credibility of learning and develop critical and creative thinking skills by having the teacher create content for a specific topic; then, students evaluate the information contained in it and verify its accuracy. It can also be used to improve students' writing and generate innovative ideas and information. Alternatively, Zhai (2022) wrote a complete scientific paper on the ChatGPT user experience and its effects on education, concluding that it is necessary to design learning tasks and activities to integrate artificial intelligence into them to help students think critically and creatively and solve real problems in society.

Dhikr Allah (2022) indicated that artificial intelligence platforms would enhance workplace environments, improve safety, and simultaneously boost productivity. Additionally, a report by McKinsey suggested that artificial intelligence has the potential to contribute approximately 1.2% annually to the global GDP, anticipating that AI could add nearly 13 trillion dollars to the global economy over the next decade. Conversely, Oki et al. (2022) argued that university curricula often emphasize superficial comprehension skills and students' interest in obtaining the main ideas of the content without delving into the knowledge and information contained in the educational content; therefore, there was a call for the need to make students think and innovate instead of reading the content superficially or writing down the most important notes contained in the educational content.

The levels of information literacy depth are known as a logical organization of knowledge and skills that a student must be able to master in any field of study according to their degree of depth and strength in four levels starting with the least in depth and strength, which is the level of memorization and reproduction, then the level of application, then strategic thinking, and finally extended thinking, which is the deepest and strongest level (Al-Feel, 2018). In this regard, the study by Robertson (2013) indicated that students who practice information literacy skills ask why and not how. Through asking these questions, they learn to understand and become more curious and interested and examine all topics, not just those topics they are presently learning. They also increase their habits of organizing ideas, processing them, and linking them together, which helps them integrate into the learning process and retain the educational material for a longer period, along with increasing their ability to apply what they have learned in their practical life.

Students in our schools learn the same content and take the same test, whether the educational content is new, well-known, or even expertly performed. In other words, one size of education fits all. However, today's students need to focus on 21st-century skills by developing levels of depth of information literacy through critical thinking, information problem solving, creativity, invention, innovation, communication, and collaboration with others. They also need to become more cultured in multiple areas, including information, media, and digital literacies, the most important of which is artificial intelligence (Schrum et al., 2018).

The importance of the depth of information knowledge is to achieve meaningful learning and link new knowledge to previous knowledge, which leads to interconnected ideas and the ability to distinguish, compare, and understand contradictory ideas (Thomas, 2017). The depth of knowledge of the information provided to learners in educational institutions cannot be achieved without providing them with meaningful experiences that link the knowledge and skills they learn inside educational institutions to their application outside them (Wamdat, 2020). The study of Al-Ubaid (2020) indicated the importance of the levels of depth of knowledge for learners in that they contribute to developing their skills and motivating them to understand things around them and get the learner to ask not how did this happen, but why did it happen. This is what creates a curious learner with a mind hungry for knowledge. This undoubtedly elevates the learner to the highest levels of understanding and develops his skills of connection, analysis, criticism, and thinking, making him look forward to continuous self-learning, especially in this era of artificial intelligence, to develop his skills and answer his questions. Indeed, this is the highest goal of the educational process.

Although many studies have focused on the role of AI in improving the quality of education, there is a research gap in the limited research that systematically and practically examines the impact of AI applications on students' cognitive depth levels (Al-Rashidi & Al-Farani, 2024). Most previous studies have focused on improving academic achievement, personalizing educational content, and enhancing learners' self-confidence, but they have not provided sufficient answers on how to enrich critical thinking and profound analysis among graduate students through AI (Lu, 2025).

In addition, there are growing concerns about the possibility of students relying excessively on AI tools to obtain information, which may lead to superficial understanding rather than developing critical analysis and deep-thinking skills (Capella, 2025). Therefore, there is a need for an in-depth study that explores how AI can be used not only as a tool for obtaining information but also as a means of developing higher mental skills, such as critical analysis, synthesis, and evaluation.

The above data demonstrates that achieving success in educational institutions requires a deep understanding of academic content, along with the ability to develop innovative projects and ideas that align with contemporary

requirements. This approach is increasingly important in light of the rapid acceleration of modern technologies and the radical transformations imposed by the Fourth Industrial Revolution in the nature of knowledge and the labor market. Conversely, relying solely on traditional learning methods, such as superficial browsing of websites, passive attendance at lectures, and taking notes without genuine engagement with the content, not only contributes to weakening cognitive comprehension but also hinders the development of creativity, innovation, and leadership skills among university students, reducing their readiness to effectively engage with future challenges.

1.1. Research Problem

As the use of AI tools spreads across educational settings, students are increasingly relying on adaptive learning systems and digital assistants to access information and solve academic problems, raising questions about the impact of this reliance on the quality of learning and the extent to which they develop critical thinking skills.

A study by Stanford University found that students who used AI applications to analyze scientific material showed significant improvements in their understanding of complex concepts, as these tools helped them simplify data and draw conclusions faster and more accurately (Lu, 2025). However, another study at the University of the Balearic Islands found that students who rely on AI technologies may suffer from a decline in critical analysis skills and the ability to independently verify information, as the system performs the tasks for them, reducing the mental challenges they face (Capella, 2025).

Considering the reality of teaching in university education, it is noticed that the usual method is still prevalent and still focuses on using the lecture method: the course professor takes up the largest part of the lecture time to deliver the content. This, however, negatively affects the level of depth of knowledge among learners, creating a lack of interest in preparing educational situations that motivate learners and develop their depth of knowledge, in addition to relying on university books and their cramming. This, in turn, leads to repeated complaints about the difficulty of courses and the low level of student comprehension, thus revealing and confirming the necessity of using modern learning resources that create learner positivity (Abdul-Alim & Ibrahim, 2022).

Al-Zain (2021) found that 90% of students watch and read what the teacher teaches but do not participate, comment on it, or engage with the educational content and are called "Lurkers," while 9% participate in creating and commenting on the educational content and publish it and are called "Commentators." Meanwhile, 1% are those who continuously create the educational content and add new elements to it and are called "Creators." As a result, there is an urgent need to achieve a deep understanding of the content of the courses presented by the teacher so that they are based on a deep understanding of the information included in any educational content and the active participation of students and their retention (Abdul Samee, 2019). In this regard, the study of Ritter et al. (2018) confirms that the educational programs offered by universities do not help students to deeply understand the information

contained in these various courses, especially the practical ones. Thus, the study recommended the need to pay attention to designing educational content that helps students to participate effectively through behavioral interaction and enhance positive responses.

The study of Al-Lawzi and Metwally (2021) showed that there is a clear weakness in the levels of depth of knowledge among students resulting from their failure to process the scientific content they study correctly, as well as their failure to train them properly to apply what they have learned in different situations. The study also indicated that this weakness can be developed when the content is presented in a way that is meaningful by linking it to reality and technological developments. The study of Abdel-Alim and Ibrahim (2022) indicated that 87% of the students of the Faculty of Education had scores less than 50% in the test of depth of knowledge levels in the course "Cloud Computing Applications." Therefore, the study recommended the necessity of developing depth of knowledge levels as one of the important learning outcomes in educational curricula at various stages.
From the above, the problem of the current research was identified as the weak levels of information literacy depth among university students; therefore, the current research seeks to address this weakness by using modern artificial intelligence platforms to develop their levels of information literacy depth.

1.2. Research Questions
The current research attempted to answer the question, "What is the effect of using artificial intelligence platforms to develop the levels of cognitive depth of information among graduate students?"

1.3. Research Hypothesis
The current research attempted to verify the validity of the hypothesis, "There is no statistically significant difference at the level of 0.05 between the average ranks of the first experimental group, which used artificial intelligence platforms, and the second experimental group, which used the usual software, in the post-application of the cognitive depth test of information among graduate students."

1.4. Research Objective
The current research aimed to develop the levels of cognitive depth in the Computers in Education course among graduate students at the College of Education through the use of modern artificial intelligence platforms.

1.5. Research Importance
The present research is important for many reasons. First, it brings to the attention of university education officials the need to focus on employing artificial intelligence applications in the field of university education. Second, it provides a smart training environment based on modern artificial intelligence platforms, which can benefit graduate students in developing deep understanding skills for academic courses, as well as producing pioneering digital works that can benefit society. Finally, it brings to the attention of university officials the need to focus on deep learning skills in all academic courses.

2. Methodology

2.1. Research Design

This study employed a quasi-experimental design with a pre-test and post-test for two non-randomized experimental groups. One group received instruction via artificial intelligence platforms (n=17), while the other was taught using traditional digital tools (Blackboard) (n=18). This design was chosen to compare the effectiveness of AI-enhanced instruction on cognitive depth development among postgraduate students.

2.2. Research Participants and Sampling Process

Participants were postgraduate students enrolled in the Computers in Education course at the College of Education, King Khalid University. A total of 35 students were selected using random sampling and were then divided into two equal groups. Prior to the intervention, Mann-Whitney U tests confirmed there were no statistically significant differences between the groups, ensuring their equivalence at baseline.

2.3. Research Instruments

The research utilized a Cognitive Depth Test designed to assess four levels of information processing: recall, application, strategic thinking, and extended reasoning. The instrument demonstrated high internal consistency with a reliability coefficient (Cronbach's alpha) of 0.89.

2.4. Data Collection Procedures

Data collection involved the pre- and post-application of the cognitive depth test. Both experimental groups underwent the same evaluation procedures. AI tools were introduced only to the experimental group during the learning intervention, while the control group continued with Blackboard.

Training content for the AI group was structured around five modules using platforms like ChatGPT, Durable, Tome, Elai, and others. Formative assessments were embedded within each lesson, with final evaluations conducted after the intervention period.

2.5. Data Analysis

Statistical analysis was conducted using non-parametric tests, primarily the Mann–Whitney U test, to compare performance between the two groups. The significance level was set at $p \leq 0.05$. In addition, effect size was calculated using eta-squared (η^2).

2.6. Ethical Considerations

All procedures followed institutional ethical guidelines. Participants were informed of the study's purpose and provided informed consent. Participation was voluntary, with the right to withdraw at any point. Data confidentiality and anonymity were maintained. The study received approval from the relevant academic and ethics committee at King Khalid University.

3. Research Procedures

To identify the effectiveness of artificial intelligence platforms in developing the levels of cognitive depth of information among graduate students at the College of Education, King Khalid University, the following was done:

3.1. Selecting the Research Sample

The research sample was selected from the graduate students at the College of Education, King Khalid University, Saudi Arabia, in a random manner and represented in two groups: the first experimental group numbered 17 students, all of whom were trained through artificial intelligence platforms; the second experimental group numbered 18 students, all of whom were trained in the usual way at the university through the Blackboard platform available at the university. To ensure the equivalence of the two groups, the research tools were applied beforehand, and the results are shown below in Table 1.

Table 1: Mann-Whitney test results in the depth of knowledge test in the pre-application

Tool Used	Number	Group	Average Rank	Total Ranks	U	Z	Sig Level	Sig
Information Literacy Depth Test	17	First	15.97	271.50	118.50	-1.210	0.226	Not Significant
	18	Second	19.92	358.50				

Table 1 shows that the calculated Z value of (-1210) in the information knowledge depth test is not significant at a significance level of 0.05, which indicates that there is no statistically significant difference between the two groups in the pre-application of the information knowledge depth test, which indicates the homogeneity of the two groups.

3.2. Preparing Research Materials

Designing a learning environment is based on artificial intelligence platforms, where some previous studies were reviewed, such as Al-Muhammadi's 2020 study and Mansour's 2021 study, and the general ADDIE design model was conducted as follows:

3.2.1. First Stage: Analysis

In this stage, the following procedures were carried out: first, the researchers started with determining the general objectives of the learning environment based on artificial intelligence platforms. The general objective of this environment is to develop levels of deep understanding of information and digital entrepreneurship in the Computer Science in Education–6000 Technology-2 course among the students in the research sample. Next, there comes the determining of the characteristics of learners, who, in this case, are graduate students at the College of Education at King Khalid University in Abha, Saudi Arabia, and are studying the course Computer Science in Education–6000 Technology-2 during the second semester of the academic year 2022/2023. Also, both groups have similar skills in

using computers and the Internet, and they share the same environment. There were 17 students in the first experimental group and 18 students in the second experimental group. Finally, there are the capabilities of the educational environment where artificial intelligence platforms were used (poe.com), and the educational material included five training units.

3.2.2. Second Stage: Design

The design stage includes defining the procedural objectives of the learning environment based on artificial intelligence platforms, developing a comprehensive vision of the content, the learning strategy, the various activities appropriate for it, and the evaluation methods, which include the procedural objectives of the learning environment based on artificial intelligence platforms as follows:

3.2.2.1. Topic One: Computer Software

After completing this content, the student should be able to discuss what software is, explain the types of software, compare different application software, and design a professional presentation.

3.2.2.2. Topic Two: Uses of Computers

After completing this content, the student should be able to explain the uses of computers in education, discuss the patterns of computer use in educational contexts, use electronic content authoring tools, and design interactive electronic content.

3.2.2.3. Topic Three: Electronic Mind Maps

After completing this content, the student should be able to understand what electronic mind maps are, explain their importance, design an electronic mind map, and publish it effectively.

3.2.2.4. Topic Four: The Internet and Education

After completing this content, the student should be able to understand what the internet is, differentiate between the internet, an intranet, and the World Wide Web, then discuss the most important internet services used in education and design an interactive educational website.

3.2.2.5. Topic Five: E-learning

After completing this lesson, the student should be able to discuss what e-learning is, explain its importance, differentiate between its various types, and design a professional interactive video. Moreover, based on artificial intelligence platforms, the content of the learning environment included the following topics: computer software, computer uses, electronic mind maps, internet and education, and e-learning. Furthermore, taking into consideration the procedural objectives and the content of the learning environment, the learning strategy using artificial intelligence platforms proceeded according to the following flow map:

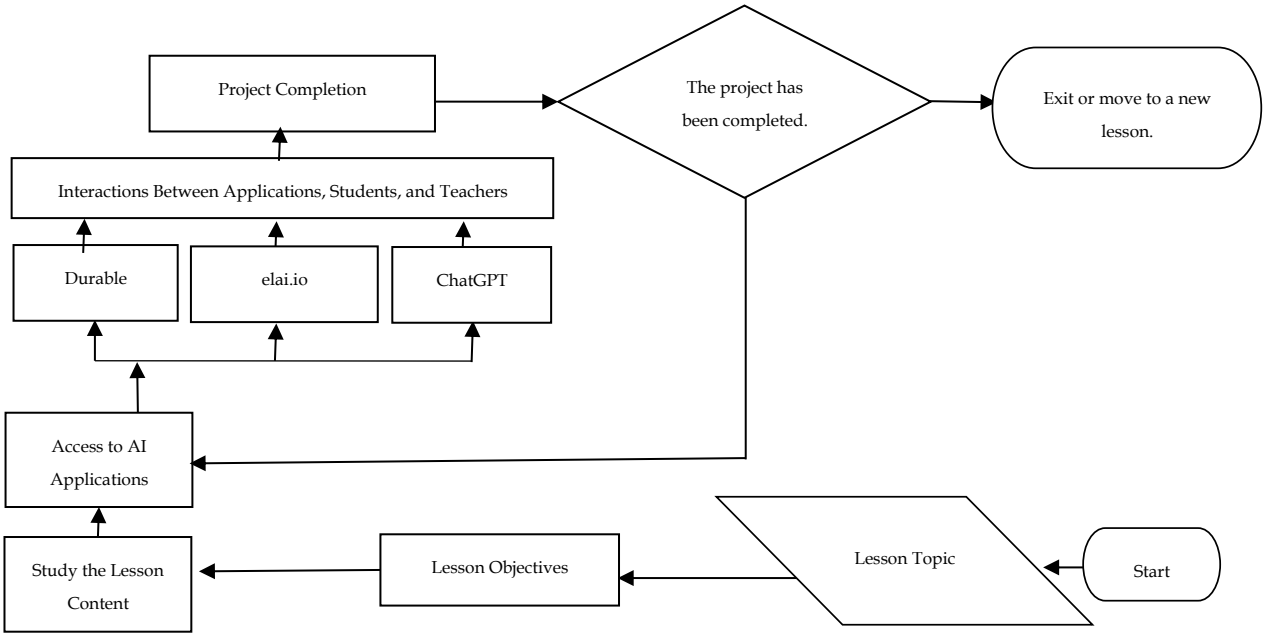

Figure 1: Flowchart of the learning strategy via artificial intelligence platforms

Finally, in the last part of Stage 2, the evaluation methods varied to include pre-evaluation at the beginning of each topic to assess previous learning, formative evaluation during each content to guide student learning and provide feedback, and final evaluation, which is done after completing the study of all training content designed according to artificial intelligence platforms to assess the development of levels of depth of information knowledge among the research sample.

3.3. Stage Three: Development Stage

In this stage, researchers used some of the following artificial intelligence platforms:

1. To run ChatGPT: poe.com
2. To design professional videos: elai.io
3. To design professional presentations: tome.app
4. To design electronic mind maps: whimsical.com
5. To convert images to a professional video: www.d-id.com
6. To design a professional website: durable.co
7. To design and create an educational lesson: www.tutorai.me

3.4. Stage Four: Implementation Stage

In this stage, the electronic content was applied to artificial intelligence platforms for 50 users. Additionally, how to access these platforms and the tasks required to be performed were also explained.

3.5. The Fifth Stage

In this stage, the training content designed according to artificial intelligence platforms was presented to a group of specialists in the field of educational technologies and information technologies. After studying all the training content

among the students of the research sample, measurement tools were also applied, including the information depth cognitive test, the digital entrepreneurship scale, and a product evaluation card.

3.6. Preparing Performance Measures

The test aimed to measure the levels of depth of information literacy among graduate students at the College of Education, King Khalid University, Abah, Saudi Arabia, in the Computers in Education course. The first level was recall and reproduction, where each paragraph at this level is given one point. This level consisted of 10 paragraphs. After presenting the test to a group of arbitrators and assessing it exploratorily on 14 students, the test reliability was calculated using the Pearson equation, and it was found to be equal to 0.89, an appropriate percentage for the test reliability.

3.7. Conducting the Research Experiment

Students received two-hour training sessions at the beginning of the study, which included a practical explanation of how to use each of the AI tools used in the study, like ChatGPT, Tome, Elai, Whimsical, and Durable, for example. Application examples and practical exercises were provided for each tool. A digital interactive electronic guide was provided to the students containing steps for using the platforms, frequently asked questions, and screencasts to ensure self-mastery. Furthermore, during the implementation period, weekly online support sessions of 45 minutes were held to answer questions and assist students in implementing AI-related projects and activities.

4. Research Results and Discussion

After monitoring the students' grades in the post-application of the information knowledge depth test in the Computers in Education course, the research questions were answered as follows:

The first question was, "What is the effectiveness of using artificial intelligence platforms to develop the levels of information knowledge depth among graduate students?" To answer this question, the following hypothesis was formulated: There is no statistically significant difference at the level of 0.05 between the average ranks of the first experimental group and the second experimental group in the post-application of the information knowledge depth test among graduate students.

To assess the validity of this hypothesis, statistical processing was conducted using the Mann–Whitney U test for two independent samples to compare the scores of the information knowledge depth test application for the first experimental group and the other experimental group. Table 3 shows the results of applying the test to indicate the difference between the ranks of the first experimental group and the other experimental group in the information knowledge depth test in the Computers in Education course.

Table 2: Results of the Mann-Whitney test in the information literacy depth test in the post-application

Tool	Number	Group	Average Rank	Total Ranks	U	Z	Sig Level	Sig
Information Literacy Depth Test	17	First	27.00	459.00	00.00	-51.064*	0.001	Significant
	18	Second	9.50	171.00				

Table 2 shows that the calculated Z value of -5.064 in the information literacy depth test is significant at a significance level of 0.05, which indicates the existence of a statistically significant difference between the two groups in the post-application of the information literacy depth test in favor of the higher average ranks, that is, in favor of the first experimental group that used artificial intelligence platforms.

Thus, the first hypothesis of the research hypotheses was rejected. There is a statistically significant difference at the level of 0.05 between the average ranks of the first experimental group and the second experimental group in the post-application of the cognitive depth test of information in favor of the first experimental group that used artificial intelligence platforms.

The researchers believe that the previous result can be attributed to the following: These platforms provide user-friendly interfaces, allowing easy and quick access to scientific content and seamless sharing with both students and instructors. These features facilitated student engagement and greater engagement in the learning process of the Computers in Education course. Furthermore, AI platforms provided immediate support for understanding complex and difficult topics, allowing students to ask questions and receive immediate and relevant answers. The integration of AI with content-sharing technologies enhanced peer interaction, contributing to a deeper understanding of the material.

These platforms also created personalized learning environments, where each student could access specific information tailored to their individual needs without the need for technical expertise, promoting deeper levels of knowledge acquisition. Furthermore, the availability of immediate feedback, along with the ability to store and retrieve information at any time, contributed to enhanced student understanding. AI platforms are primarily based on the philosophy of deep learning, providing access to comprehensive databases and prompting learners to ask additional questions related to the content to enhance critical thinking and understanding. As a result, the use of these platforms has significantly contributed to developing the depth of knowledge of graduate students in the Computers in Education course.

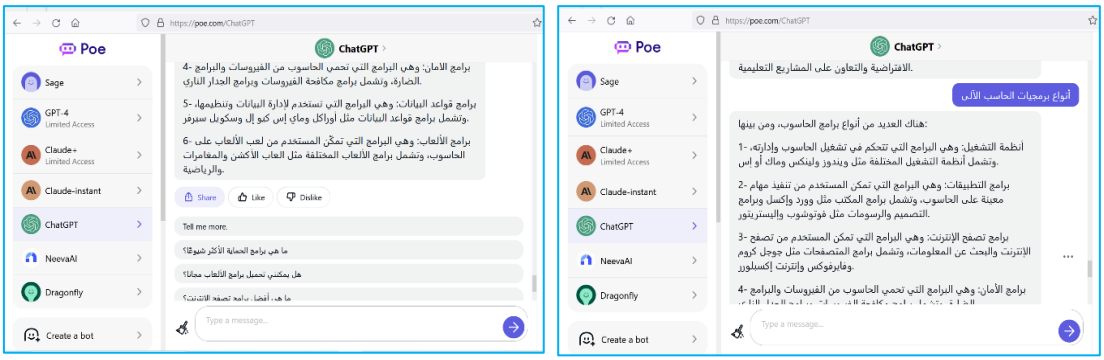

Figure 2: Students discussing academic content with AI

The results of this research are partially consistent with Lu (2025), who highlighted the benefits of AI in simplifying complex academic content. However, unlike Capella (2025), who raised concerns about overreliance on AI tools potentially impairing critical thinking, the current findings suggest that when intentionally integrated into structured learning environments, AI enhances—rather than hinders—cognitive depth. Participants reported using AI platforms not only to retrieve information but also to synthesize and evaluate ideas, supporting the transition from passive to active learning.

Moreover, qualitative feedback from participants supports the statistical findings. Over 90% of participants indicated that ChatGPT helped them break down complex concepts into manageable steps, making studying less daunting. One said, "I was able to immediately test my understanding and rephrase my questions, something that would not have been easy for me to do in regular lectures." These responses demonstrate the vital role AI platforms have played in promoting deep learning behaviors. The findings of this research expand upon previous work by Chai (2022), which emphasized the importance of designing learning tasks that actively engage students in the use of AI. Our approach included these structured tasks, which may explain the significant differences observed between the experimental and control groups. The combination of immediate feedback, personalized content, and student-led interaction in this study presents an AI-based learning model that promotes higher-order thinking.

In conclusion, while this research supports previous claims about the usefulness of AI in education, it also makes a unique contribution by providing empirical evidence of the development of cognitive depth in graduate students. Future research should explore the long-term effects of these interventions and examine their applicability across different academic fields and learner types.

Scientific and Practical Significance of the Research Results

Through Table 2, the researchers explain the practical or applied importance of the research results by finding the effect size of the independent variable on the dependent variables.

Table 3: Scientific and applied importance of the research results

Independent Variable	Independent Variable	(Z)	Eta Square η^2	Effect Size
AI Platforms	Depth Of Information Knowledge	-5.064	0.75	Big

It is clear from Table 3 that the effect size of artificial intelligence platforms on developing levels of cognitive depth of information among graduate students at the College of Education, King Khalid University, is 0.75, which is a large percentage, and the rest is due to various other factors, including the students' previous experience and technological skills, the students' environment, peers, and other factors.

5. Discussion of the Research Results

The research results revealed statistically significant differences between students in the first experimental group, who used AI platforms, and students in the second group, who relied on traditional methods. Students in the first group outperformed in the depth of information literacy test, indicating the effectiveness of AI in promoting deep understanding, conceptual comprehension and application, and strategic and extended thinking. These results can be explained by the characteristics of AI platforms, such as an easy interface, quick access to content, immediate interaction, and personalized support tailored to each student's needs (Lu, 2025; Halaweh, 2023). These platforms enabled students to organize their thoughts, generate innovative ideas, receive immediate feedback, and enhance their analytical and critical skills, leading to a deeper level of knowledge.

The results indicate that integrating AI into learning environments can transform university education by enhancing critical thinking, increasing student engagement, empowering students to learn independently, and producing creative digital works. These results underscore the need to develop modern AI-based educational strategies to meet the demands of the digital age (Zawacki-Richter et al., 2024; Hwang & Chang, 2024).

Despite the positive results, the study suffers from some limitations, including a relatively small sample size (only 35 students), which limits the generalizability of the results; a reliance on a single discipline (the "Computer Science in Education" course), which calls for caution in applying the results to other disciplines; and a short duration of the experiment, which may not reflect the long-term impact of AI use on the depth of knowledge.

Traditional methods, such as the typical use of Blackboard, rely on the direct transmission of information from teacher to student without promoting interaction or analytical thinking. Furthermore, students in traditional settings tend to be passive recipients and are required to memorize content rather than analyze it or apply it to new contexts, limiting access to higher levels of cognitive thinking. The lack of immediate feedback and student-level-specific activities in

traditional methods also weakens motivation and engagement, reducing opportunities for strategic or expansive thinking.

Based on the above, this research recommends the integration of AI technologies into university courses, particularly those related to computing and education; the development of training programs for faculty members to effectively employ AI in teaching and assessment; the development of interactive AI-based assessment tools to measure the depth of knowledge and higher-order thinking skills; and the conduct of future studies that examine the impact of AI on other skills such as creativity, problem-solving, and self-learning across multiple academic disciplines.

6. Conclusion and Recommendations

This research makes a unique contribution to the field of AI-based learning by empirically demonstrating that structured use of AI platforms significantly enhances cognitive depth among graduate students, not merely academic achievement. Unlike prior studies that focus on content personalization or surface-level outcomes, this study highlights the role of AI in fostering higher-order thinking skills such as analysis, synthesis, and strategic reasoning. By leveraging platforms like ChatGPT, students engaged more deeply with the material, illustrating that AI tools, when thoughtfully integrated, can transition learners from passive content consumers to active knowledge constructors. This contribution fills a critical gap in the literature and paves the way for rethinking how AI can be harnessed in higher education to advance meaningful learning.

In conclusion, this research proves that AI represents a qualitative shift in university education, as it is no longer just an assistant tool but has become an essential element in achieving effective learning. Therefore, investing in the development of AI-based learning environments is an imperative necessity to keep pace with rapid digital transformations and to ensure the preparation of more efficient students who can interact with the challenges of the digital age.

Research Recommendations

Based on the current research results, the following recommendations can be made:

1. Pilot and Scale Research on AI's Impact in Various Educational Contexts: Encourage future longitudinal and cross-disciplinary studies that explore the role of AI in enhancing soft skills (e.g., creativity, collaboration) and professional readiness. This can support policymaking in digital transformation strategies in education.
2. Design AI-Based Assessment Tools to Evaluate Higher-Order Thinking Skills: Develop robust AI-driven evaluation systems that can assess students' critical thinking, reasoning, and problem-solving skills. These tools should provide real-time feedback and enable adaptive testing environments that cater to students' evolving learning needs.
3. Develop Faculty Training Programs Focused on Pedagogical Use of AI: Universities should offer structured, practical training sessions to faculty members. These should focus on designing AI-enhanced lessons, using AI for

formative assessments, and developing strategies to mitigate overreliance on AI, ensuring students remain active participants in the learning process.

4. Integrate AI Platforms into University Curricula Across Disciplines: University decision-makers should implement AI-supported learning environments not only in computer-related courses but across various academic fields to promote cognitive depth, critical analysis, and synthesis of knowledge.
5. This research recommends the development of clear regulatory and ethical frameworks for the use of artificial intelligence in education, balancing the benefits of technological capabilities with the reduction of associated risks, particularly in educational environments that seek to develop deep thinking and cognitive independence.
6. Conduct longitudinal studies to measure the sustainability of the cognitive impact resulting from the use of artificial intelligence and the extent to which acquired skills remain after varying periods of time.

Conflict of Interest

The authors declare that there is no conflict regarding the publication of this paper.

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