

## Learning Outcomes in the Era of AI

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### ABSTRACT

This study, "Learning Outcomes in the Era of AI," examines the impact of artificial intelligence (AI) on students' cognitive learning of Microsoft Excel calculations and commands. Using a pre-test/post-test design with two instructional approaches—conventional lectures and AI-assisted activities—the findings revealed that students performed better after human-led instruction, while AI-assisted learning resulted in decreased retention and problem-solving ability. The results suggest that excessive reliance on AI may hinder critical thinking and conceptual understanding. Therefore, while AI can support the learning process, its integration must be balanced and guided by educators to ensure meaningful and sustainable learning outcomes.

## INTRODUCTION

We are operating in an unprecedented time in education in the 21st century, where the application of artificial intelligence (AI) has created significant changes in teaching and learning. There are now various types of AI tools that offer a range of services for education from intelligent tutoring systems (ITS) to generative types of AI technologies like ChatGPT, they have changed the way students' access, interact and process educational material during the learning process. This includes automating a task, providing feedback in an instant, clarifying a complex concept, and increasing efficiency in acquiring information.

However, a great deal of aspects arises from the positives as well. As educators/researchers notice, there is a more subtle, yet consequential, approach to learning, primarily with using AI-generated content for an extended time. Instead of truly engaging with their academic materials, some learners, over time, become reliant on AI-assisted methods, which may decrease their opportunities to normally build capacity for critical thinking, procedural learning, and cognitive independence.

This study, *Learning Outcomes in the Era of AI*, aims to determine how students use AI tools to acquire knowledge and use Microsoft Excel step-by-step calculations and built-in commands. Being able to use Excel both for academic and workplace readiness is a skill that has to be mastered. Mostly, the study investigates the impact of learning outcomes when students learn under the direction of teacher, versus learning with AI-assisted learning activities. Early findings indicate that there was a significant decrease in the post-test scores from students who participated in the AI-supported learning activities.

When it comes to artificial intelligence (AI) in education, most studies have zeroed in on how it can boost learning through personalization, instant feedback, and overall efficiency. Researchers like Cui et al. (2019) and Baillifard et al. (2023) have pointed out that AI can really enhance student engagement and success with adaptive learning systems. However, these studies tend to focus on the positive aspects of AI, often overlooking its potential downsides on cognitive and procedural learning outcomes.

There's a noticeable gap in research regarding how a long-term dependence on AI tools might negatively impact students' critical thinking, information retention, and procedural understanding – skills that are crucial for effective learning and being job-ready. This concern is especially pertinent in areas like procedural learning, such as using Microsoft Excel, where mastering the material relies heavily on logical sequencing, analytical thinking, and independent problem-solving. If students lean too much on AI-generated content, they might miss out on truly engaging with the step-by-step processes, which could lead to poorer retention and less cognitive independence.

In the Philippines, most existing research has mainly looked at students' attitudes and how they use AI tools (Fabro et al., 2024; Ortiz Jr. et al., 2025). However, there's a lack of studies that delve into how AI affects learning outcomes in skill-based subjects. This highlights an urgent need to explore whether AI-assisted learning actually helps or hinders students in mastering concepts and procedures in spreadsheet applications.

AI can be a useful resource for students in their educational journeys, however, an over reliance upon it may hinder students cognitive understanding and ability to problem-solve on their terms, even within skills-based contexts, for example, an application like Microsoft Excel. This paper argues that AI can support or detract from an authentic learning experience, and with careful consideration and appropriate use of AI, we can incorporate both into the curriculum.

This study holds significant value for a wide range of educational stakeholders. For educators, the findings can transform teaching methods by offering solid evidence on how students' learning behaviors and cognitive engagement shift when AI tools are involved. Recent research, like that of Tamim et al. (2023), pointed out that while AI-supported instruction can boost efficiency and motivation, it might also lead to a decline in active cognitive engagement if not implemented thoughtfully. By shedding light on this balance, educators can create classroom experiences that effectively incorporate AI tools while still fostering students' independent thinking and critical reflection.

For curriculum developers, this research provides a solid foundation for crafting learning modules that responsibly integrate AI technologies. Luckin et al. (2023) and Duan et al. (2024) stressed that curriculum design should go beyond merely adopting tools; it should also nurture digital discernment and cognitive resilience, ensuring that the use of AI enhances deep learning rather than diminishes it. The insights from this study regarding how AI influences students' procedural and conceptual mastery in Microsoft Excel can inform the development of similar technology-integrated courses in other skill-based areas like statistics, programming, and data analysis.

For students, this study highlights the importance of being aware of their own thinking processes and finding a healthy balance when using digital tools. As Park et al. (2024) discovered, students who leaned too heavily on generative AI tended to show less motivation and struggled with self-regulation over time. By pinpointing patterns of reliance on AI, this research encourages reflective learning – prompting students to consider when and how to use AI effectively to enhance their understanding instead of letting it take the place of their own efforts.

For school leaders and policymakers, this study offers localized, evidence-based insights that can shape national policies regarding AI integration in education. The Department of Education (DepEd) has started working with tech companies to boost AI literacy (Microsoft News, 2025), but there's still a lack of solid data from classrooms in the Philippines. The findings from this study can serve as a crucial foundation for creating AI competency frameworks and training programs that ensure the adoption of technology aligns with cognitive development goals and national education standards.

In the end, this research is important because it adds to the global conversation about responsible AI use in education while also addressing local gaps. It provides empirical evidence on how AI impacts learning outcomes in procedural and skills-based subjects—areas were grasping the process, not just the end

result, is key to mastering the material. It supports the broader educational aim of nurturing AI-literate, critically engaged, and independent thinkers.

### ***Transition Enhancement (Between RRL and Synthesis)***

Alongside the studies we've already talked about, recent meta-analyses have really emphasized the need to strike a balance between using AI and engaging our minds. Tamim et al. (2023) and Zawacki-Richter et al. (2023) pointed out that while AI tools can boost efficiency and motivation, relying too much on automation might actually hinder our higher-level thinking skills, like analysis and evaluation—key components of Bloom's Taxonomy. Additionally, Kasneci et al. (2023) and Park et al. (2024) found that if students become too dependent on generative AI, it could lead to cognitive offloading and a decline in their ability to self-regulate their learning, which echoes the concerns raised by Risko and Gilbert (2016) about the risks of outsourcing our mental tasks.

In developing countries like the Philippines, these insights are even more significant. There's still a lack of local research that dives into the long-term effects of AI on teaching and learning in procedural settings. By filling this gap, the current research not only builds on international findings but also roots them in a specific, culturally and technologically relevant context, providing valuable insights into how we can harness AI for learning while still preserving our essential cognitive abilities.

## **LITERATURE REVIEW**

Artificial intelligence (AI) has transformed education and learning environments with recent developments like intelligent tutoring systems, adaptive learning systems, and content-generating AI applications, like ChatGPT (OpenAI, 2023). These technologies have the potential to enhance students' learning experiences by providing personalized, efficient, and engaging education. For instance, Cui et al. (2019) demonstrated that students engaged with adaptive AI-powered learning systems in mathematics and English achieved significantly higher scores compared to those in traditional settings. Similarly, Baillifard et al. (2023) observed that GPT-powered tutors using spaced-retrieval practices improved neuroscience students' conceptual retention by approximately 15 percentile points.

However, Holmes et al. (2020) warned that overreliance on AI may turn students into passive knowledge receivers rather than active participants in constructing their own knowledge, undermining deep learning and long-term retention. This risk is magnified when learners copy AI-generated answers without reflecting on the reasoning behind them, leading to poor analytical and problem-solving skills development.

The dangers of AI dependence are especially evident in procedural and technical domains like Microsoft Excel. Brown (2019) emphasized that trial-and-error problem-solving promotes critical thinking and reasoning, while excessive reliance on AI or automated tools reduces meaningful learning. Reyes and Santos (2022) found that senior high school students relying on Excel's built-in formula generators took longer to finish tasks and scored lower in independent evaluations than those practicing manual calculations. Lee and Han (2023)

further noted that students using AI chatbots to complete spreadsheet assignments often failed to internalize formula logic, instead memorizing final answers without developing metacognitive skills.

Ahmed and Abdullah (2023) stressed that AI should be used as a "cognitive amplifier," encouraging students to verify, reflect, and adapt AI outputs. Without this critical engagement, learners develop only superficial understanding. Astuti and Bhakti (2023) reported that manual exploration of formulas in Excel resulted in stronger problem-solving skills and deeper comprehension than auto-calculation tools. Similarly, Zulkarnaen et al. (2024) highlighted that spreadsheet-based activities fostered higher-order thinking only when learners actively created formulas, visualized data, and corrected their own errors.

In the Philippine context, the Department of Education (DepEd), in partnership with Microsoft, is introducing AI-driven tools like Microsoft 365 Copilot to enhance productivity and learning outcomes (Microsoft News, 2025). Local research by Fabro et al. (2024) revealed that Filipino students have generally neutral but growing positive attitudes toward AI tools, with widespread usage of applications like Grammarly and QuillBot. However, teachers reported confusion and misalignment between AI outputs and local pedagogical methods (Ortiz Jr. et al., 2025), highlighting the need for AI literacy programs and teacher training.

Intelligent tutoring systems for Excel learning have shown potential in balancing guidance and autonomy. Aguirre Reid et al. (2023) developed an AI-powered feedback system that analyzed student spreadsheets and offered hints instead of direct answers, resulting in improved learning outcomes by fostering independent problem-solving and critical thinking.

In conclusion, AI presents promising opportunities for enhancing education, particularly when combined with traditional hands-on problem-solving approaches. In skill-based subjects like Microsoft Excel, overreliance on AI may hinder meaningful learning, critical thinking, and metacognitive development. Effective integration of AI should complement rather than replace cognitive efforts, ensuring learners acquire transferable skills and genuine conceptual mastery.

Artificial Intelligence provides advantageous options in education; however, its adoption should be considered a balanced, educational decision-making process. In skill-based subjects such as Microsoft Excel, if students over rely on AI, they may only engage in surface level learning, think less critically about problems, and may not develop any metacognitive awareness. Using AI is educational and a good practice if it maximizes the cognitive processes that are essential to meaningful learning, not replaces them.

### *Synthesis of Literature*

Artificial intelligence (AI) has the power to revolutionize education by offering personalized, efficient, and engaging learning experiences. This is made possible through technologies like intelligent tutoring systems and adaptive learning platforms, as highlighted in studies by Cui et al. (2019) and Baillifard et

al. (2023). However, there's a flip side to this potential: the risk of encouraging passive learning and a shallow grasp of concepts (Holmes et al., 2020; Ahmed & Abdullah, 2023). When students simply copy AI-generated answers or lean too heavily on automated tools without diving into the reasoning behind them, they miss out on developing crucial analytical, problem-solving, and metacognitive skills (Lee & Han, 2023).

This issue is especially critical in procedural and technical fields like Microsoft Excel, where hands-on, trial-and-error problem-solving is essential for deep learning and critical thinking (Brown, 2019). Research shows that students who depend too much on auto-calculation or formula generators tend to perform worse and take longer to finish tasks compared to those who engage in manual, reflective calculation and formula creation (Reyes & Santos, 2022; Astuti & Bhakti, 2023; Zulkarnaen et al., 2024). The general agreement is that AI should act as a "cognitive amplifier," pushing students to critically assess, reflect on, and adapt AI outputs instead of replacing their cognitive efforts (Ahmed & Abdullah, 2023). In the local Philippine context, there's a growing, albeit complex, adoption of AI tools like Microsoft 365 Copilot, highlighting an urgent need for AI literacy and training to connect technology with local teaching methods (Microsoft News, 2025; Ortiz Jr. et al., 2025). The exciting development of intelligent tutoring systems that provide hints rather than direct answers (Aguirre Reid et al., 2023) suggests that a balanced approach can effectively nurture both guidance and independent problem-solving.

### ***Research Gap and Hypothesis Development***

The literature has made it clear that AI-powered adaptive or tutoring systems offer numerous benefits (Cui et al., 2019; Baillifard et al., 2023; Aguirre Reid et al., 2023). However, it also highlights the risks of becoming overly dependent on general content-generating AI for procedural tasks (Lee & Han, 2023; Reyes & Santos, 2022). Yet, there's still a significant gap in our understanding of the specific cognitive and learning outcomes that arise from a well-structured, balanced AI integration model, especially within the context of senior high schools in the Philippines.

Most of the local research has primarily focused on teachers' attitudes and their readiness to adopt these technologies (Fabro et al., 2024; Ortiz Jr. et al., 2025). What we really need is empirical evidence that directly compares the effectiveness of three different instructional methods: Traditional Manual Practice, Unrestricted AI-Assisted Learning (which can lead to overreliance), and a Structured AI-Integrated Approach (which promotes reflection and critical engagement). This comparison should focus on metacognitive awareness, critical thinking, and true conceptual mastery in a highly procedural subject like Microsoft Excel.

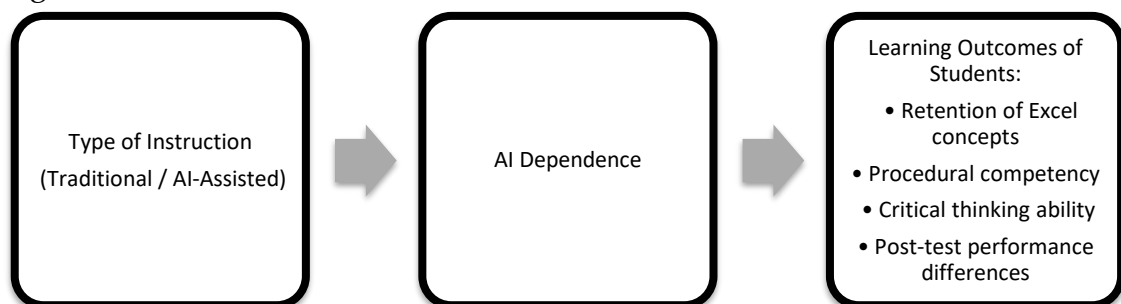
This study aims to fill that gap by exploring a teaching model for Excel that intentionally uses AI as a cognitive amplifier. This approach is based on the idea that learners should actively construct their knowledge (Holmes et al., 2020) and critically assess AI outputs (Ahmed & Abdullah, 2023).

### *Hypothesis Development*

Drawing from the existing literature, we propose the following hypotheses:

- Hypothesis 1: Senior high school students who participate in the Structured AI-Integrated Approach, which emphasizes active verification and reflection on AI outputs, will show significantly greater improvements in their metacognitive awareness of spreadsheet formula logic compared to those in the Traditional Manual Practice group and the Unrestricted AI-Assisted Learning group.
- Hypothesis 2: We expect that senior high school students who participate in the Structured AI-Integrated Approach will score significantly higher on a challenging, transferable problem-solving task—one that assesses their critical thinking and understanding of concepts—compared to their peers in the Unrestricted AI-Assisted Learning group. This aligns with previous research suggesting that hands-on exploration and actively creating formulas lead to a deeper grasp of the material (Astuti & Bhakti, 2023; Zulkarnaen et al., 2024).
- Hypothesis 3: On the other hand, students in the Unrestricted AI-Assisted Learning group, who may be prone to overreliance on technology, are likely to score the lowest in an independent assessment of their conceptual understanding and critical thinking skills. This is in line with concerns about superficial learning and the potential decline in their analytical abilities (Reyes & Santos, 2022; Lee & Han, 2023).

This research is grounded in different educational theories. First is Cognitive Load Theory (Sweller, 1988), which suggests that a human can only manage a limited amount of cognitive information at once. Overuse of artificial intelligence may lessen mental effort, and therefore a less meaningful experience. Second is Bloom's Taxonomy, which privileged higher-order thinking when looking at deep learning: analyzing, evaluating, and creating. The continued use of artificial intelligence appears to keep students grounded in lower order forms of cognition, when they should have or could have advanced to higher order cognition.



**Figure 1. Conceptual Framework of the Study**

## **METHODOLOGY**

### *Study Design*

Using a descriptive-quantitative research design allowed the researchers to assess and compare identified student learning outcomes past, present, and future in AI-enhanced learning environments. Employing descriptive research

allowed for accurate treatment of student performance in three instructional contexts: traditional class discussions, AI-assisted activity, and standardized independent post-assessment regarding intention measures. A quantitative approach was important as it would permit the use of statistical instruments to objectively quantify the differences among scores to assure conclusions about the meaningful learning represented by the actions of students in AI-assisted learning sessions. The researchers were interested in identifying behavioral patterns and understanding, and measurable changes in performance, including instances where learners had to make choices about understanding and explaining Microsoft Excel step-by-step calculations and built-in commands.

### ***Context and Locale of the Study***

The research was carried out in one public senior high school in the Philippines which is the Villaba National Comprehensive High School and involved three sections of Grade 11 students in the subject Empowerment Technology. These were identified as 11-Athena, 11-Aphrodite and 11-Hermes. The school has an applied track subjects in curriculum that includes computer applications, which is an appropriate context for investigating AI integration in tasks involving spreadsheets. All students experienced Microsoft Excel in basic ICT classes; however, they had experienced little or no AI tools while learning. The literature review suggested that a balanced action research study needed to be conducted in the context of a typical classroom where students had access to tools, but teachers had not yet begun to adopt them as part of their delivery strategies.

### ***Participants***

A total of 101 students from three senior high school sections participated in the study. The participants were distributed as follows: 39 students from Section 11-Athena, 36 students from Section 11-Aphrodite, and 26 students from Section 11-Hermes.

The sample size was determined by the total number of enrolled students in the three sections for SY. 2025-2026 who agreed to voluntary participation, based on informed consent that had been obtained from the students and their parents or legal guardians. Students were not excluded from the study based on gender, academic achievement, or familiarity with the content to include a widely representative participation in the sample.

### ***Data Collection Instruments***

Two principal tools were designed and used to measure the learning outcomes in this study. The first tool was a validated researcher-made assessment that included six items to measure students' knowledge of Microsoft Excel specifically in relation to step by step calculations and built-in commands such as SUM, AVERAGE, IF, and Cell Reference. The assessment has been \*semi\*- validated by Information and Communications Technology (ICT) teachers, meaning it was measured for brief comprehensibility, topicality, appropriateness to the curriculum map, and was all completed prior to this Phase of the study. It was used as both the pre-test and post-test so that I could measure

the growth of understanding from before the intervention to after the intervention.

The second tool was an AI-assisted Class Activity worksheet that required students to work on activities that incorporated AI tools, including generative and all chatbots like ChatGPT, and Excel built-in calculation tools. The workbook was structured using simulations of "real-world" scenarios, such as grade average calculator, inventory counting, as well as perfect applications of step-by-step built-in calculations regarding things like cell references. I rated student performance on the class activities to determine if students were able to effectively use the AI tools as part of their learning.

### *Data Gathering Procedures*

The procedure utilized in this study was divided into 3 distinct phases. The first phase was the pre-test phase, and students were taught in the traditional way - lecture and discussion. After the instruction period, students completed a pre-test of Excel step-by-step calculations without the assistance of any artificial intelligence tools. The intention of the first phase was to determine what students had in their minds as they enter the course.

The second phase was the AI activity. In this phase, students were introduced to some AI tools. These tools were provided with tasks that included using AI to complete the Excel based tasks. Students used the AI to create suggestions, explain calculations in a step-by-step manner, and to automate Excel built-in commands. The students' performance during the AI activities were recorded so that their understanding of the efficiency of AI tools was captured, and how to apply practical problems.

The last part was the post-test part. After completing the AI-supported activities, the students were asked to take the same assessment they took in the pre-test but, this time was without AI tools. This was to see how much knowledge the students were able to retain and internalize independently, and without AI, after the experience of AI-integrated learning.

### *Treatment of Data*

The study took a mixed-methods approach to dive into the data, mainly relying on quantitative statistical techniques to gauge learning gains and retention across three assessments: the Pre-test, the AI-assisted Class Activity, and the Post-test. All the responses collected were neatly organized and analyzed using both descriptive and inferential statistics.

### *Descriptive Statistics*

Mean Scores and Mean Percentage Scores (MPS): The key metrics calculated were the mean scores and Mean Percentage Scores (MPS) for both the Pre-test and Post-test. This gave us a clear, objective snapshot of how the group performed before and after the intervention. The MPS was essential for making standardized comparisons across different classes.

MPS

$$= \frac{\text{Total Possible Score} - \text{Pre-test Mean Score}}{\text{Total Possible Score}} \times 100$$

Post-test Mean Score–Pre-test Mean Score

Standard Deviation (SD): We calculated the standard deviation for the Pre-test and Post-test scores to measure how much the scores varied within the student group. This helped us understand the consistency of learning outcomes.

Performance Rating for AI-assisted Activity: We used descriptive statistics (mean score, SD, and frequency distribution) to analyze the performance data from the AI-assisted Class Activity. This helped us quantify how well students were able to integrate and apply AI tools for problem-solving in Excel.

### *Inferential Statistics (Measuring Growth and Retention)*

Paired Samples t-test: To see if the AI-assisted learning intervention led to a significant improvement in student knowledge, we conducted a Paired Samples t-test.

This test compared the mean scores from the Pre-test with those from the Post-test.

The null hypothesis was tested (H<sub>0</sub>: There's no significant difference between pre-test and post-test scores) against the alternative hypothesis (H<sub>a</sub>: There is a significant difference), typically using a significance level of  $\alpha=0.05$ .

Table 1. Student performance between pre-test scores from traditional lecture-based instruction and post-test scores

Section	Pre-Test (MPS)	AI Activity (Estimated Mean & MPS)	Post-Test (MPS)
<b>11-Athena</b>	0.46 (7.60%)	4.84 (80.76%)	0.31 (5.18%)
<b>11-Aphrodite</b>	1.16 (19.44%)	4.44 (74.07%)	0.83 (13.88%)
<b>11-Hermes</b>	1.03 (17.30%)	4.30 (71.79%)	0.52 (8.66%)
<b>Overall</b>	0.86 (14.35%)	–	0.61 (10.18%)

The revised post-test results reflect a substantial drop in students' performance after the AI-assisted phase. In fact, at 11-Athena post-test (5.18%) was below that of 11-Athena's pre-test (7.60%), suggesting limited retention for some students, and perhaps regression. Some sections, such as 11-Aphrodite and 11-Hermes, had slightly improved scores on their post-test from the pre-test scores, but still far below their scores during the AI-supported phase, as can be seen in Table 4. Overall, the average test dropped from 14.35% (pre-Test) to 10.18% (post-test); a drop that raises concerns of dependence to the bad effects on students' independent learning.

### *Ethical Considerations*

The study was conducted in accordance with ethical standards for educational research. Informed consent was received from all study participants and their guardians. Participants were given a brief overview of their right to opt-out of the study at any time and without consequence. The names or identification of student responses were not made available to any other person; student anonymity and confidentiality were ensured. The study was also

reviewed and permitted by the ethics review committee at the school and followed research procedures established by the Department of Education.

The use of a structured methodology makes the evaluation of the students' construction of learning about the role of AI legitimate, credible, and ethical. Through following the phases of instruction and continual assessment, this study captures the learning that took place associated with the students' use of AI.

## **RESEARCH RESULT**

### *Overview of Findings*

The primary goal of the study was to assess whether students' artificial intelligence (AI) technologies promote authentic student understanding or only assist with short-term performance. The results from the pre-test, AI activity, and post-test were compared to assess knowledge retention and cognitive engagement.

The AI activity scores look to indicate a better performance than normal as all three sections had above 4 out of 6 averages during the AI-supported portion of the activity. That is, the students relied on the AI methods and suggestions such as the step-by-step calculations, autofill methods, and chatbot version toward finding the correct answer. There was, however, a dramatic knowledge loss presents in the post-test results. In every section, the scores were so much worse in the students' first exam when they did not have A.I. support, that they performed worse compared to their AI activity into the post-test. Section 11-Athena had the most concerning post-test score of dropped to an average of 5.18% which is even karma compared to their 7.60% pre-test assessment, this not only indicates a total void of retained learning but three steps back in understanding the material. Clearly there was a non-consistent learning trend and serious confounding issues, such as whether the students learned the material or not.

Moreover, the results highlight the detrimental aspects of a dependence on an AI tool. Students who relied too heavily on an AI during their practice time appeared to have skipped over some of the essential concepts of learning. In their rush to get an answer they did not do much real problem-solving; they simply mimicked whatever the AI showed them to do without processing the information being presented to them. As such, they learned less, understood less, and created a habit of expecting technology to solve their problems. As such, a reliance on AI is damaging to their cognitive development and it hampered their abilities to use skills with goal directed and critical thinking on their own.

### *Interpretation of Findings*

The interpretation of findings indicates that Section 11-Athena had a pre-test mean score of 0.46, which increased to 4.84 in the AI stage, only to drop significantly to 0.31 in the post-test, which suggests that comprehension declined. Section 11-Aphrodite had slight improvement shown in the post-test scores as compared to their pre-test scores, however, both were ultimately well below the scoring achieved while supported by AI. Section 11-Hermes had a moderate increase from the pre-test to the post-test but still was scoring well below their

AI stage. Collectively, the pattern shows a similar trend: once AI support was terminated, students' scores drastically fell, suggesting an unstable understanding of the lessons.

### *Presentation of the Results*

In this section, we provide a quantitative analysis of students' performance in three major parts of the assessment. The assessment took place in a pre-test after the traditional discussion, an AI-enabled activity where they conceptualized their assignment, and a post-test after the AI activity (but this test was administered without the use of AI). We examined how well students were able to understand and retain knowledge about built-in commands and step-by-step calculations in Microsoft Excel.

Table 2. AI-assisted activities affect students' critical thinking and problem-solving skills (pre-test)

Section	Pre-Test Purely Discussion						Mean	MPS
	<i>Excel Basic Formula</i>			<i>Excel Functions</i>				
<i>Item No.</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>		
<b>11-Athena</b> <i>Students: 39</i>	2	2	2	4	4	4	0.46	7.6
<b>11-Aphrodite</b> <i>Students: 36</i>	7	7	7	7	7	7	1.16	19.44
<b>11-Hermes</b> <i>Students: 26</i>	9	9	9	0	0	0	1.03	17.30
<b>Total: 101</b>	<b>18</b>	<b>18</b>	<b>18</b>	<b>11</b>	<b>11</b>	<b>11</b>	<b>0.86</b>	<b>14.35</b>

The results show little prior knowledge in all sections following a conventional approach to teaching with discussions. Section 11-Athena had an MPS (7.60%) while 11-Aphrodite scored slightly higher. These scores represent the starting point for judging the effectiveness of AI.

Table 3. AI-assisted activities affect students' critical thinking and problem-solving skills (post-test)

Section	Post-Test (After the activity using AI tools)						Mean	MPS
	<i>Excel Basic Formula</i>			<i>Excel Functions</i>				
<i>Item No.</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>		
<b>11-Athena</b> <i>Students: 39</i>	1	1	1	2	2	2	0.31	5.18
<b>11-Aphrodite</b> <i>Students: 36</i>	4	4	4	3	2	2	0.83	13.88
<b>11-Hermes</b> <i>Students: 26</i>	3	3	2	1	1	1	0.52	8.66
<b>Total: 101</b>	<b>8</b>	<b>8</b>	<b>7</b>	<b>6</b>	<b>5</b>	<b>5</b>	<b>0.61</b>	<b>10.18</b>

Although all sections had prior exposure to an AI tool, all sections' post-test average scores were low. The MPS for 11-Athena decreased from 7.60% (pre-test) to 5.18% (post-test), which indicated that the students regressed rather than improved. 11-Aphrodite and 11-Hermes had almost no retention of knowledge in the context of the next assessment. Although there were slight increases in these students' scores from their pre-test scores, their overall retention of knowledge was poor when compared to their scores with the AI tool. When looking at all sections together, the average overall mean value decreased from 14.35% (pre-test) to 10.18% (post-test) which clearly illustrated that using the AI tool did not transform into long-term learning.

## DISCUSSION

The results of this study highlight a distinct performance trend: students showed a notable improvement when they had the support of artificial intelligence (AI) tools, but their scores took a significant hit in the post-test once that support was removed. This indicates that while AI can boost short-term performance, it doesn't necessarily lead to lasting comprehension or genuine understanding. This pattern echoes the findings of Kasneci et al. (2023) and Duan et al. (2024), who noted that although AI tools can enhance immediate productivity, they might inadvertently stifle deeper cognitive engagement and the development of lasting knowledge.

We can look at this phenomenon through the lens of cognitive offloading theory, which suggests that people often hand over mental tasks to external devices or tools to lighten their cognitive load (Risko & Gilbert, 2016). During the AI-assisted phase, students leaned heavily on features like step-by-step explanations and auto-calculation functions. While these tools made problem-solving easier, they also reduced chances for mental practice, encoding, and self-correction—essential processes for retaining information. Similar observations were made by Tamim et al. (2023), who found that learners supported by AI performed well during sessions but struggled with recall later, reinforcing the idea that cognitive offloading can negatively impact long-term learning.

Moreover, the way students mimicked AI-generated steps without enough reflection ties into the worked-example effect, where learners only benefit when they actively explain each step to themselves (Renkl, 2017). Without guided self-explanation, AI-generated examples may lead to a superficial understanding of procedures but fail to foster deeper conceptual insights. Park et al. (2024) also pointed out that generative AI can disrupt self-regulated learning when students use it to generate answers instead of as a collaborative partner for exploration and reasoning.

This study aimed to investigate whether tools of artificial intelligence (AI) support meaningful learning of students in the learning of Microsoft Excel. Although the scores yielded during the AI-supported conditions may seem promising at a first sight, the actual picture seems different, as a direct comparison between pre-test and post-test shows that students did not retain and understand the content when AI support was faded.

To appreciate this result, consider the instructional context and objective of pre-test and post-test cycles. Pre-test was taken following traditional lecture and discussion but without AI tools being utilized. It was intended to measure students' initial knowledge of Excel step-by-step calculations and built-in commands. The teaching was entirely human, and students experienced personal interaction through notetaking, listening and problem solving. While scores, in general, were low, they were indicative of real and unaided understanding, displaying a basic degree of control at the very least.

The post-test, meanwhile, took place after students took part in an AI-assisted activity, for which they used tools such as ChatGPT and Excel's re-programmed features to solve problems while receiving instant support. No AI was permitted at the actual POST-test, however. The goal was to assess how much knowledge students could remember and could apply on their own following the AI-assisted stage. The results indicated a dramatic decline in performance from both the AI phase and the pre-test - particularly in Section 11 - Athena where the mean percentage score of the post-test was lower than their original pre-test. This is not only an issue of forgetting but an alarming deterioration of learning. Dominance of the two measures differed only in the specificity of their instruction: The pre-test was a traditional cognitive demand, cognitive-demanding task, and the post-test was a phase on AI that facilitated passive consumption of information. This contrast appears to show that the students relied on the AI system too much, leading to a lack of internalization in the learning process.

One of the important implications of these findings is that in the AI-assisted stage, students may learn little or no meaningful material. While they finished the tasks at seemingly high success rates, they did so by cheating on the fly, using AI-produced, step-by-step solutions or having chatbots generate the answer – a virtual student version of phoning a friend during a game show. They were not engaged in knowledge building so much as being filled with knowledge.

This is consistent with the Technology Acceptance Model (TAM) which states that even if students perceive artificial intelligence tools as easy to use or useful regarding performance, these advantages do not guarantee a deeper understanding. Without entering the areas of critical thinking, reflection, or authentic application, an individual learns nothing more than superficial learning that fails to last beyond a specific task.

Section 11-Aphrodite displays a significant regression relative to Athena. They very much did well in AI activity, but they go worse down on their post-test than on the already low pre-test scores. It might mean that the use of AI tools has assisted them in unlearning or perhaps has shifted students' cognitive engagement so that there is disintegration of knowledge construction. Instead of improved learning, here AI tools interrupt the process.

In summary, AI tools may briefly boost performance, but they do not lead to long-term understanding or mastery of skill. In fact, these tools might undermine long-term understanding when not properly guided or balanced with instruction. Therefore, it is fundamental that AI is based on thoughtful

integrations to support, rather than undermine, teacher-led instruction, metacognitive reflection, and student-cognitive learning practice.

## CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, the following are the conclusions:

1. The comparison of pre-test and post-test scores showed no significant improvement after AI-assisted activities. Some sections, like Section 11-Athena, even declined in performance, supporting Null Hypothesis 1 and rejecting Alternative Hypothesis 1 – AI use alone did not enhance learning outcomes.
2. Students also failed to apply critical thinking in the post-test, heavily relying on AI during the activity without understanding the logic. This supports Null Hypothesis 2 and rejects Alternative Hypothesis 2, indicating no improvement in higher-order thinking skills.
3. There was no notable retention or mastery of Excel concepts, with AI reliance hindering internalization. Thus, Null Hypothesis 3 is accepted, and Alternative Hypothesis 3 is rejected AI did not aid conceptual mastery.
4. A clear pattern emerged: students who overused AI scored lower without it. This supports Alternative Hypothesis 4 and rejects Null Hypothesis 4, confirming that AI overdependence negatively impacts performance.
5. Finally, structured teaching strategies helped promote balanced AI use. With teacher guidance and metacognitive support, students used AI more responsibly. This supports Alternative Hypothesis 5 and rejects Null Hypothesis 5 – structured instruction enhances meaningful AI integration.

### *Recommendations*

In response to the challenges identified, the following recommendations are suggested. - Human-led reinforcement – There must be a human-led reinforcement – for example, human led-discussions after each AI activity that guides the teacher to advocate for an offline task reinforcing understanding and reflection. Second, encouraging metacognitive reflection is essential; students should learn to critically judge AI output, check their own work, and trust themselves to apply their knowledge without being artificially scaffolded. The third type is gradually from the AI tasks to the non-AI tasks. For instance, students should start learning with AI tools but ultimately take tests on their own to create lasting understanding and self-reliance. A fourth requirement is that clear AI usage policies must be set. Educational institutions and teachers should establish ethical, structured, and balanced principles of integrating AI into educational space. Fifth, teachers should be ready for the future of education, with professional development organized to enable teachers to use AI effectively and to conduct digital pedagogy. Lastly, it's important to perform longitudinal models. Future work should provide long-term studies, exploring the sustainability of AI-enhanced learning scenarios within different fields in sense of academic performance and durable learning outcomes.

## ADVANCED RESEARCH

Future research should adopt longitudinal and mixed-method approaches to explore the long-term cognitive and behavioral effects of AI-assisted learning across disciplines. Using tools such as cognitive load analysis and structural equation modeling, studies can identify key factors—like self-efficacy, critical thinking, and instructional design—that influence whether AI enhances or hinders learning. Cross-context comparisons should also examine how teacher readiness and institutional policies affect AI integration. Ultimately, this research aims to develop an evidence-based framework for balanced human–AI collaboration that supports critical thinking and lasting understanding.

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