Issues in Information Systems
Volume 26, Issue 2, pp. 1-13, 2025

DOI: https://doi.org/10.48009/2_iis_101

Assessing IS learning outcomes effectively in the age of GenAI

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Abstract

The recent, rapid expansions of artificial intelligence (AI) technologies, and especially web-based generative AI tools (GenAI), has radically changed the field of education. These changes have forced educators to reconsider the teaching instruments they deploy, and the methods they use, to formatively and summatively assess student learning. This paper represents a work-in-progress case study conducted in a senior-level college course on database administration and NoSQL. Quantitative and qualitative observations from a class of 24 students majoring in Information Systems (IS), Information Technology (IT), and Cybersecurity disciplines at a large, regional public university are reported. Findings include self-reported measures of student use of GenAI to complete technical tasks, along with comments and recommendations from students regarding their experience using GenAI in the class, especially on the final project. The paper concludes with observations about how and when to use GenAI in teaching and learning, methods for documenting and demonstrating student learning, and future research in this area.

Keywords: generative artificial intelligence, AI, summative assessment, IS pedagogy, learning outcomes

Introduction

This research examines the impact of generative AI (GenAI) tools on higher education within an information systems course at a large state university. The primary question investigates educators' ability to effectively assess course learning outcomes now that GenAI is capable of completing many of the assignments, labs, exams and other learning instruments that have long been used to drive student learning. Are educators adequately adapting how they teach and assess learning in the GenAI age, and how might we improve adaptation to the benefit of student learning?

In the fall of 2022, the release of ChatGPT 3.5 as a web browser-based generative AI tool sent shockwaves through the education profession. Competing technologies such as Claude, Gemini, and others quickly followed, amplifying those waves (Garcia-Penalvo, 2023). Suddenly, people of all walks of life had free access to powerful, highly capable artificial intelligence solutions that could produce useable content in seconds. By the time ChatGPT 4 was released in the spring of 2023, it was clear there would be no escaping GenAI's impact on education at all levels, from Kindergarten to graduate school and beyond (Haugom & Lyocsa, 2023).

Educators worldwide found that in many cases, the teaching instruments they had developed and used, often over the course of many years of professional teaching, were suddenly problematic at best, and obsolete at worst. This is because a well-crafted and articulately worded assignment, quiz, or other assignment is often an ideally engineered prompt for a GenAI technology (Adeshola & Adepoju, 2024). Teachers and students

alike quickly found that many formative and summative assessments—homework problems, quizzes and exams, projects, etc.—could be easily copied and pasted into a GenAI tool with a usable solution returned in seconds (Lim, et al., 2023).

Reactions to this quantum leap forward in technology ranged from panic and fear to excitement and optimism (Koh, et al., 2023). Some educators swiftly implemented total bans on the use of GenAI for schoolwork, complete with severe consequences for violations (Koh, et al., 2023). Others reacted with curiosity and innovation by incorporating GenAI into some aspects of their classes (Koh, et al., 2023). Still others began adding GenAI requirements to their courses. These responses to GenAI's existence and evolution have led to myriad discoveries among educators. These realizations are the genesis of this paper's research question:

RQ: *In the age of generative AI, how do we effectively assess student achievement of course learning outcomes (CLOs)?*

To address this question, we developed, deployed, and assessed three formative assessments and one high-stakes summative assessment in a senior-level college course on Database Administration and NoSQL. At the end of the summative assessment, students were invited to complete a voluntary, anonymous survey regarding their experiences using GenAI in the course. Their responses were then collated with their actual performance on the final project—the summative assessment—to establish how, and how well, students achieved the learning outcomes for the course.

Literature Review

Technology has a long history of disrupting education. Saettler (1968) traced the impact of technology on education from its earliest uses in human education. He further examined the revolutionizing effects of computer-based technologies on education from the 1950s up to the beginning of the Internet Age (Saettler, 1990). Online, open, and collaborative learning platforms proliferated throughout the 1990s and 2000s, once again transforming the educational experience (Andergassen, et al., 2015). And within the past 20 years, significant leaps forward have occurred in distributed, rich, highly interactive educational experiences and environments (Haggag, et al., 2025; Uka, Morina & Kowch, 2025). Given technology's track record as a disruptor of pedagogical practices and learning techniques, GenAI's transformative power, for better or for worse, comes as no surprise to educators. It is the latest in a long history of technologies that have influenced the way people teach and learn.

Viewed through this historical lens, GenAI is simply the latest technology to profoundly impact education. But given GenAI's substantial capabilities to not just develop or deliver educational content but also *to complete it*, we know that teachers' reactions to this disruptive technology must not be over-simplified. Vhatkar, Pawar and Chavan (2024) have synthesized research conducted within the past two years that focuses specifically on GenAI's impact on education. Within their review, these researchers identified published works in 2023 and 2024 that studied the impacts GenAI has on instruction and learning within science and technology disciplines. Primary themes that emerged from their study include the following:

- Knowledge retention and skill demonstration in college STEM courses decreased in students who self-identified as using GenAI on their homework (Chan & Hu, 2023; Cooper, 2023).
- Students and faculty currently have widely differing views and uses for GenAI in college courses. Students often over-rely on GenAI for completion of work, thus replacing their own learning—intentionally or not—with little more than automated content production. Faculty meanwhile lack

understanding, clear communication of expectations, and recognition of GenAI capability and content. (Smolansky, et al., 2023).

- GenAI is becoming an essential technology skill for today's workforce. Instructors should incorporate generative and agentic AI instruction into their technology courses as an essential skillset for the modern workforce. AI tools can be used to create, deliver and assess academic work (Salinas-Navarro, et al., 2024; Wang, et al., 2023).
- Despite concerns regarding cheating, GenAI is an important technology for students to learn for improvement of the quality, efficiency, and effectiveness of their work. Instructors are responsible to teach learners about the ethical and effective use of AI in completing school work. (Akinrinola, et al., 2024; Rane, 2024).

The question of how to appropriately use technology is therefore one that educators must answer, and then re-answer, each time a new tool or product emerges. In teaching and learning, one of the common matters of 'appropriate technology use' revolves around academic integrity (Kazley, Andresen, Mund, Blankenship, & Segal, 2025). What constitutes dishonesty in an academic setting has long been hotly debated, and often focuses on the wrong thing (Nikolic, et al., 2023; Sweeney, 2023). The argument is older than using calculators on math tests. But research has repeatedly shown that focusing on the use or non-use of technology in teaching and learning usually misses the point (Weng, et al., 2025; Luke, 2019; Olsen, et al., 2019).

While it is true that technology can be used to replace learning, and that this action by learners most often would constitute cheating, the technology or use of it is not, in-and-of-itself, cheating (Fernando Juárez, & Rudick, 2025; Luo, 2025). Technologies are regularly employed as teaching and learning tools to the benefit of both teachers and learners. Therefore, educators must ensure that expectations are clearly communicated about how, when, and where tools can be used by learners (Heather, 2018). In the absence of tools that could be used to replace learning, educators have been free to create exercises and assessments that students had to do themselves—there was simply no other way to complete their schoolwork (copying or outsourcing notwithstanding). But when a technology is created that can complete assigned work for the student, the educator must act to ensure that the student is not acting against their own best self-interest; ostensibly by using technology to complete their schoolwork for them without actually learning the material (Chan, & Colloton, 2024).

It is from this perspective that this research began. As researchers and professors of information systems (IS), we accept that society creates, adopts, and retains technologies that create value, or at least, are perceived as creating value. (Audretsch, et al., 2023). When a technology does create value, even if that technology poses a potential risk for learning replacement, it is unwise and likely impossible to legislate that technology out of the education/learning space through policies, proctoring, or punishment (Abdallah, 2024). It is also unfair to students who, once they graduate, will need to compete in a workforce that will value and even demand knowledge and skill with such technologies (Wilen, 2025). Thus, the challenge to educators is to incorporate emerging technologies into our instruction while preserving the ability to assess the extent to which the student has learned.

This requires focusing on the right issues in pedagogical design, in order to preserve the ability to assess learning while also including use of the technologies in the learning process (Gaumann, & Veale, 2024). This will often be dependent on the subject matter, and the learning to be achieved; however the principle of retaining the ability to assess students' learning is the same for any instructional activity in any subject. A professor teaching first-year writing, or one teaching introductory computer programming, both face essentially the same obstacle: creating assignments, exams and projects that may, or may not, be completed by a machine but still require students to learn (Bowen, et al., 2024). In instances where student learning,

knowledge, skills, and abilities can only be assessed without the presence of technology, formative and summative assessment must be created within a set of rules and an environment where the technology cannot be present (Guruge, et al., 2025; Waltzer, et al., 2024). But educators should not assume that this is always the case, or that making the technology a part of the learning is necessarily fatal to the ability to assess the learning (Naseem, 2023). This assertion, and the cited literature within this paper upon which this assertion is based, forms the foundation for this paper's primary question: How can we continue to effectively assess student learning in technology-oriented college courses while incorporating GenAI into our instruction?

Methodology

To address this primary research question, a final project was designed to replace a long-standing final exam in a senior-level college course on database administration and NoSQL. As both action research and a work-in-progress case study, the scope of the participant group was limited to a single class of 24 students. The final project was designed as a high-stakes summative assessment, worth 22% of the students' final grades in the course. GenAI was used by the professor to help prepare the final project, and GenAI was intentionally incorporated as a resource for students to accomplish the required tasks.

To help students to prepare for these tasks, and to help them learn to use GenAI constructively in their learning, three GenAI-driven formative homework assignments were given throughout the semester. Students were also allowed to use GenAI on some of their other homework assignments during the semester if they wished. There were aspects of the class where GenAI was expressly prohibited as well, so communication about use or non-use of GenAI was carefully and repeatedly provided.

Before the three formative homework assignments and the summative final project were given, the course learning outcomes (CLOs) were reviewed to ensure that they were sound, relevant, current, and still applicable in the age of GenAI. They were found to be appropriate, so no modifications were made. The CLOs are listed below in Table 1.

Table 1. Course Learning Outcomes

CLO
1. Install/configure DBMS
2. Maintain instances/databases
3. Optimize/troublshoot database
4. Data management, backup automation
5. Database security, authorization
6. High Availability solutions
7. NoSQL administration and coding

Three different software systems were used to expose students to different kinds of databases: (1) a proprietary, enterprise-class database, (2) an open-source database, and (3) a NoSQL database. The systems used are Microsoft SQL Server, MySQL, and MongoDB, respectively.

The three GenAI-driven formative assessments mapped to CLOs 3, 4, and 7. For all three of these assignments, students are instructed, in writing, that they can and should consider using GenAI to help them complete the tasks. They are given instructions of what tasks to complete, and what evidence they must submit to document their work. They are also instructed to document their use of GenAI, including prompts they use and content produced by GenAI that is part of their submission.

The assignment for CLO 3 required students to debug and secure application code that interfaces with a MySQL database. The code contains ten errors and five vulnerabilities that students must identify, explain in writing, and correct. On the assignment for CLO 4, students write scripts that automate nightly backups of SQL Server and MySQL database systems. The assignment for CLO 7 has students run a prepared script that converts a relational database in SQL Server to a document store database in MongoDB, and then answer 10 questions by writing queries in JavaScript Object Notation (JSON) and explaining both the code and the answer to the question in writing. All of the tasks in these three assignments are assisted and accelerated by the use of GenAI. Students must identify what portions of their submitted work were generated by AI and which were generated by them. These three assignments are given in weeks 4, 8, and 13 of a 16 week semester.

The final project is given to the students in week 9 and due at the end of week 16, giving students more than a month to complete it. All seven of the course's CLOs are addressed in the project, which is organized into three parts, consisting of six multistep database administration tasks. Part one, containing tasks 1 and 2, tests students' abilities to correct a corrupted database backup file and use it to recover from a MySQL database failure. Part two, containing tasks 3 and 4, requires students to convert that database to a secure, high-availability SQL Server database system. Part three, containing tasks 5 and 6, has students design and implement a document store database in MongoDB that preserves the schema design and data integrity of the SQL Server database. As they complete these required tasks, students demonstrate professional communication and presentation skills by preparing a report documenting and explaining their work, including all code they wrote or produced (with or without using GenAI), and all manual processes they completed. Within this report they identify which portions they produced and which portions were produced by GenAI.

To create a database of sufficient size and complexity for this final project, multiple GenAI tools were used to produce the MySQL database consisting of thousands of records in tables with dozens of relationships, keys and constraints, dependencies, and attributes. GenAI was used to introduce ten specific errors within the database backup script. GenAI was used to assist in wording the tasks required in the project to ensure students would have to demonstrate their own knowledge even in cases where GenAI might complete some, or all, of the technical work in the task. GenAI was also used to produce a grading rubric that included all seven of the course's CLOs, aligned with the tasks required in the project.

The project requirements were passed into ChatGPT 4o mini with a prompt to create a grading rubric. The instructor then modified the rubric to redistribute some points, ensure that partial points could be granted for partial mastery of required elements, and to simplify some components of the rubric. The resulting rubric distributes 50 points across 11 required elements. These include both project preparation and presentation, and skill demonstration. Point values range from two to five points for each element. Mastery of an element results in full points for an element, while demonstration of partial knowledge and skill would garner partial credit for that element. Assignment of zero points for any element only occurred if that element was missing from the student's submission. The rubric enables assessment of the CLOs while evaluating the students' knowledge of database administration skills, with and without the assistance of GenAI.

To complement the assessment of student learning via the final project grading rubric, students were invited to complete a five-question suvery about their experiences working on the project, including their use of GenAI as a learning tool. Three Likert-scale questions prompted students to share their interactions with GenAI as they accomplished the required coding tasks, and two open-ended written questions allowed students to provide personal feedback. Due to page constraints, we have not included the project rubric or

student survey with this paper, but will provide it upon request using the author contact information in the paper's header.

Findings

All but one of the 24 students in the class completed the project. Twelve were Information Systems majors, nine majored in IT, and three in Cybersecurity. Two students submitted the project before the beginning of week 16, four submitted it before the last day of week 16, and 17 submitted it on the due date. Only one student failed to complete all of the tasks, turning in a partial project.

The mean score on the final project was 89%. This is substantially higher than the mean score of 82% for final exams administered in the same class over the past three academic years. Both the project and the exam assess the same CLOs, however student participants in this project performed essential database administration tasks better with the benefit of more time to complete the assessment and the ability to use GenAI to assist them in their work. Table 2 summarizes student achievement of the seven course learning outcomes, relative to their performance of the tasks on the final project.

Table 2. Student CLO Achievement

CLO	Maps to Project	Students Demonstraing Competency
8. Install/configure DBMS	Task 2	23 of 23 (100%)
9. Maintain instances/databases	Task 4	19 of 23 (83%)
10. Optimize/troublshoot database	Task 1	19 of 23 (83%)
11. Data management, backup automation	Task 5(a)	21 of 23 (92%)
12. Database security, authorization	Task 3	20 of 23 (87%)
13. High Availability solutions	Task 5(b)	18 of 23 (78%)
14. NoSQL administration and coding	Task 6	19 of 23 (83%)

On average, about 87% of students demonstrated competency across all six tasks, suggesting that the class did achieve the course learning outcomes with a high degree of success. Using the rubric against the students' submitted reports, which included self-disclosure of where they did, and did not, use GenAI to complete their work, the instructor was able to successfully assess the degree to which students reached competency for the CLOs.

Our findings were inline with the existing literature that state the importance of adapting pedagogical and assessment strategies based on technological advancements but that student learning outcomes must remain intact (Chan & Colloton, 2024; Gaumann & Veale, 2024; Bowen, et al., 2024). Bowen et al., (2024) specifically mentioned the importance of creating assignments or projects that can be completed using advanced technology but still require the students to learn which was demonstrated by our findings.

The effectiveness of the use of GenAI-driven formative assessments was tested using a Pearson correlation. Student scores on the week 4, 8, and 13 assignments were correlated with their performance on the final project. The overall Pearson coefficient between the three GenAI-driven assignments and the final project is $r = 0.68$, suggesting that the formative assessment did positively prepare students for the project. Individually, the assignments also show positive correlation to project performance:

- The week 4 assignment on debugging and securing application/database interface code correlates to final project task 1 with a coefficient of $r = 0.49$.
- The week 8 assignment on automating database backups correlates to final project task 5(a) with a coefficient of $r = 0.64$.
- The week 13 assignment on NoSQL schema development and JSON querying correlates to final project task 6 with a coefficient of $r = 0.91$.

It is interesting to note that there is a progression in the correlations between the three GenAI-driven formative homework assignments and the students' performance on the summative counterpart tasks on the final project (0.49 to 0.64 to 0.91). There are several possible explanations for this progression, including issues of familiarity, acceptance, and recency. Such explanations were not tested in this research, but this phenomenon may represent an opportunity for future research. While this specific progression warrants further study, the overall positive correlation (r=0.68) in our fidings does align with the existing literature,specifically, the challenge of balancing technological integrations with authentic learning and assessments as highlighted by Naseem (2023).

Naseem states that integrating emerging technologies into instructions is difficult to balance because often learning and learning outcomes can be negatively impacted. But Naseem also argues the assumption that the integration of emerging technologies inherently prevents effective assessments. Our broader findings demonstrated that through careful design and careful implementation AI can be used to help students effectively learn while also accurately assessing their competency. This echos Naseem's optimistic outlook on the potential of integrating emerging technologies into classroom pedagogies.

After project completion, students were invited to complete a survey of their experience with the final project. Seventeen of 23 students responded; a solid response rate for an optional and ungraded survey. Figures 1, 2 and 3 show the students' responses to three Likert-scale questions about their use of GenAI for project task completion.

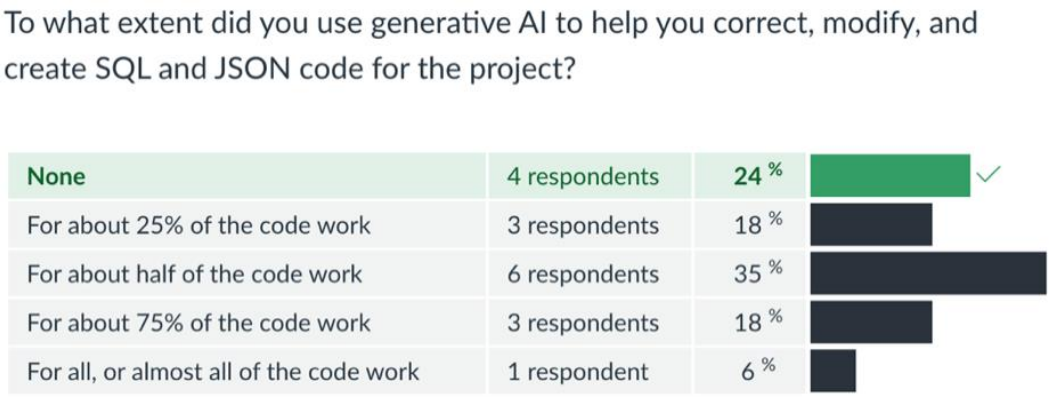

Figure 1. Degree of Student Use of GenAI on Coding Tasks

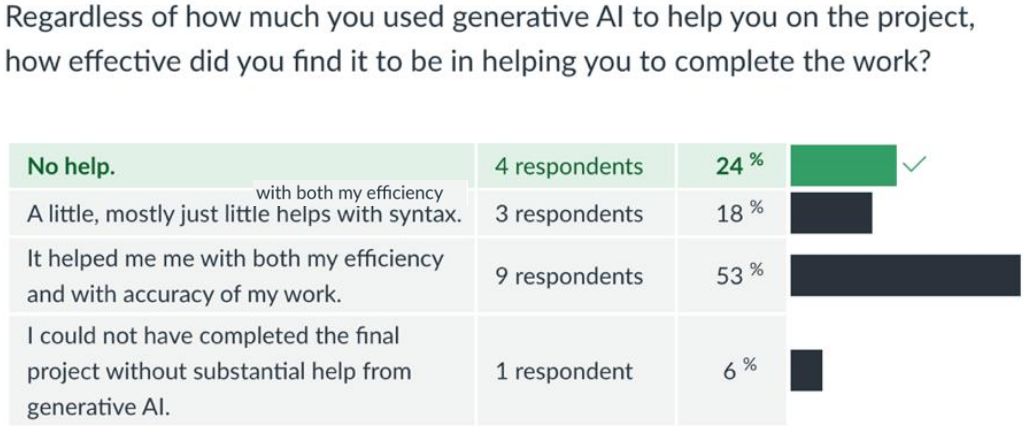

Figure 2. Student Perception of GenAI Helpfulness on Coding Tasks

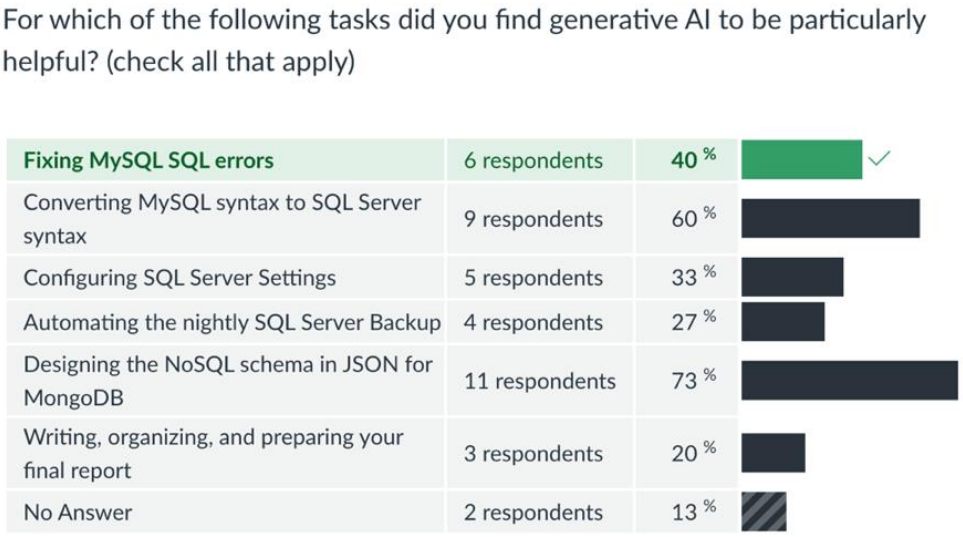

Figure 3. Student Evaluation of GenAI Helpfulness on Types of Coding Tasks

The observations from Figures 1 through 3 are consistent with the instructor's experience in grading that final projects using the rubric. Use of GenAI was allowed and encouraged, but the project was written to require students to demonstrate their knowledge and skills, not just paste the requirements into GenAI and then turn in whatever output they received. Students self-report in all three of these Figures that they used GenAI in the ways intended, and that for the most part, they did find it useful. Given the technology-savvy student group that participated in this case, it is not surprising that four of them reported not using GenAI to complete the project.

In addition to the three Likert-scale questions, two additional open-ended questions were posed to the students:

1. How do you feel about generative AI's impact on your learning as a college student?
2. Across this final project, which tasks did you find most challenging, and what strategies (AI or otherwise) were most helpful in overcoming them?

Fifteen of the 17 survey respondents provided comments, some of which were quite lengthy. In preparing this paper, ChatGPT was asked to summarize the students' responses. Though ChatGPT returned a lengthier and more detailed response, the primary summaries are shared here:

1. Most students find generative AI to be a helpful and supportive tool for learning, especially for understanding concepts, syntax, and simplifying complex tasks. However, many also express caution about over-reliance and emphasize the importance of using AI as a supplement rather than a replacement for learning. Example quotes from the student survey:
    a. "Although AI could probably do an entire assignment for me, it hurts me in the end. It's our responsibility to make sure we don't reduce our learning outcome. It would be embarrassing to fail a job interview for something that we should know."
    b. "Generative AI is a double edged sword. Not learning how to use it means missing out on the opportunity to become a more efficient and accurate technology professional. Over reliance on it can be detrimental to being able to understand what is actually happening and developing real skills."

   c. "AI to me was an effective tool to help me understand what the code was doing and how to fix potential issues. I learned the importance of using AI as a tool, not as a crutch to do it all. Thanks to research and AI, I was able to understand the errors and how to fix them. Seeing the code working afterward gave me a sense of completion and satisfaction."

2. Students found encryption, code conversion to JSON, and debugging to be the most challenging tasks. Generative AI was most helpful when used with precise prompts and in combination with other learning strategies like revisiting class content and external tutorials. While some students found AI less effective in complex or sensitive tasks (like user permissions), many found it valuable for simplifying syntax, explaining errors, and offering general guidance. Example quotes:
   a. "I think the most that gen AI helped me was converting my SQL Server to JSON. I did not use it that much when correcting errors as SQL Server and MySQL pointed me to the issue with the in house error messages."
   b. "I only had us AI on the encryption step to ensure I was creating the Symm key with the correct syntax. It helps my problem-solving by enhancing my learning capabilities and refreshing my memory. It enhances my learning by being able to identify concepts so that I can cross reference AI's answer to those of reliable sources."
   c. "I found that the most monotonous task was fixing the code and AI could help me do that quickly."

The open-ended questions answered by the participants reflect the findings in existing literature. Our results demonstrate how projects and assessments can be curated to allow students to demonstrate their knowledge and skills, not just copy and paste. Our findings show a shift in focus from AI tool use to an actual demonstration of learning which is essential in the integration of new technology in classroom pedagogy (Luke, 2019; Olsen, et al., 2019; Sweeney, 2023; Weng, et al., 2025). Additionally, our participants indicated that they felt AI was a supplement to their learning rather than a replacement which was an important distinction made by Juarez and Rudick (2025) and Luo (2025). Although not specifically asked, students reported using ChatGPT, Microsoft Copilot, and Google Gemini to help them complete their work on the project.

Conclusions

Education is not stagnant. Technological progress has always required adjustments to be made to pedagogical practices. From the introduction of the calculator to the computer, internet, Google, smartphones, and now GenAI, educators have needed to learn how to adapt to these technologies. Educators constantly need to learn how to integrate new tools to aid in learning while preserving student engagement and learning outcomes. As a small-sized case study (i.e., one class, N=24), this experiment was successful in achieving its objectives. The project within this study demonstrated that GenAI, when integrated successfully, can align with course learning outcomes in a way that enabled the instructor to effectively assess student achievement. The GenAI-driven formative assessments showed positive influence on summative assessment outcomes. Students reported how much they relied on GenAI to complete their work and described the types of experiences they expected to have with the tool. Notably, their qualitative reflections aligned with their final project performance.

One of the important takeaways from this study is that in the age of generative AI, teaching and learning must include a strong instructor/student partnership (Heather, 2018). Of the technological advancements seen over the past century, none have had more potential of replacing students' learning than that of GenAI. Holding students accountable for their work and the quality and depth of their learning has never been more

challenging (Chan, & Colloton, 2024). Thus, this partnership between teacher and learner will require substantial honesty and trust, along with intentional, clear, and carefully crafted communication regarding expectations, requirements, and deliverables. In building upon the existing literature that emphasizes the disruptive impact of technology in education (Haggag, et al., 2025; Uka, et al., 2025), this study reinforces the ideas that faculty members can, and in many cases must, change and update their teaching strategies, methods, and instruments. This will ensure student learning remains intact while holding students accountable to act in their own best self-interest as they acquire and apply knowledge and skills that create value in the age of GenAI.

This study was limited to only one class and a small sample size (N=24). This limitation may affect the findings' generalizability. However, it provides a valuable framework for integrating GenAI technology within the classroom that preserves course learning outcomes and pushes students to remain accountable for their learning. Future research should expand upon this initial case study, examining this framework among various subjects and disciplines to enhance generalizability and develop best practices for classroom-based GenAI use.

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