

The Perceptions of GenAI Tools in Lesson Planning: Implications for Science Teacher Education

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This exploratory study examined how early-career teachers in a science, technology, engineering, and mathematics (STEM) methods course, the majority of whom were science teachers, engaged with generative artificial intelligence (GenAI) tools in lesson planning, examining patterns of use, perceived affordances and challenges, and factors influencing adoption. Grounded in the Technology Acceptance Model framework, this study investigated shifts in pedagogical knowledge and technological pedagogical content knowledge among nine participants enrolled in the course. Findings indicate that structured exposure to GenAI tools enhanced participants' confidence and competence in integrating technology into lesson design. While some participants embraced GenAI for tasks such as assessment creation and brainstorming, others paused due to concerns about accuracy, ethical implications, and reliance on district-provided or mentor-developed materials. Although the cohort included two early-career mathematics teachers, seven of the nine participants were early-career science teachers. This study highlights the importance of critical AI literacy in shaping the adoption of GenAI tools in STEM education. Implications for teacher preparation include the need for thoughtful integration, ethical guidance, and sustained professional development to support responsible and effective use of GenAI in education.

Over the past several years, the rapid advancement of artificial intelligence (AI) has sparked both enthusiasm and concern across various sectors, including education. The release of generative AI (GenAI) tools such as ChatGPT has intensified discussions about the role of GenAI in K–12 classrooms and its potential to transform teaching and learning (Smith-Mutegi et al, 2025). Educators are increasingly exploring how GenAI technologies can enhance instructional design, personalize learning, and improve efficiency in lesson preparation (Crompton et al., 2022).

Further, the adoption of GenAI tools among young people has grown rapidly. In a national survey conducted in November 2023 by the Hart Research Group and the National 4-H Council, youth aged 9 to 17 reported frequently using GenAI chatbots for entertainment, homework, and schoolwork. Around 20% of respondents used these tools primarily for academic purposes; however, over 70% expressed a need for guidance from adults to understand and use GenAI responsibly. This growing trend highlights the crucial role of teachers, particularly those in science and mathematics, in promoting students' responsible and equitable engagement with AI technologies, thereby enabling them to develop both conceptual understanding and critical thinking skills (Chiu et al., 2024).

AI broadly refers to the ability of machines to perform tasks that typically require human intelligence, such as understanding natural language, recognizing patterns, and solving problems (Dignum, 2019; Popenici & Kerr, 2017). AI encompasses diverse technologies and methodologies, including machine learning, natural language processing, data mining, neural networks, and algorithms (Agrawal et al, 2018; Baker et al., 2019). Within this expansive field, GenAI refers to machine learning and deep learning algorithms trained on large datasets to produce output based on user prompts and descriptions (Marzano, 2025; Saetra, 2023). GenAI systems are capable of generating original content, including written text, images, videos, and other media, representing a robust and evolving new category of educational technology (Marzano, 2025).

Across educational contexts, AI applications are becoming increasingly widespread. Besides its expanding role in sectors such as automotive, security, and virtual assistance, AI has shown its value in education with adaptive and personalized learning (Murtaza et al., 2022), intelligent tutoring systems (ITS), and machine learning applications, including automated essay grading (Murphy, 2019). AI has also contributed to pedagogical design processes, supporting data-driven decision-making and curriculum development (Meegan & Young, 2025). Further, it has been suggested that GenAI could level the playing field for historically underserved students and communities (Aziz, 2025; James & Andrews, 2024).

From personalized learning platforms to predictive analytics, AI is continually carving out a significant niche in educational innovation. Despite its growing influence, the use of AI in lesson planning, a foundational element of effective teaching, remains an area that warrants further exploration (Meegan & Young, 2025). GenAI tools, such as ChatGPT and Microsoft's CoPilot, are increasingly being recognized as potentially valuable resources for educators designing science lessons, developing rubrics, and creating assessments (Cooper, 2023). However, the ways these tools are perceived, employed, and integrated by STEM

teachers, particularly those in the early stages of their careers, is still relatively unknown.

Although many educators express interest in the pedagogical possibilities of AI, they often report having limited knowledge about how to use it effectively in classroom settings (Chounta et al., 2021; Kim & Kim, 2022). There is also growing recognition of the need to ensure that AI integration in education upholds ethical principles and maintains educational quality (Zawacki-Richter et al., 2019). Asim et al. (2022) asserted that teacher educators should prepare teacher candidates to use the technology most available to students. Recent research also suggests that targeted professional development focused on GenAI tools can improve teachers' self-efficacy and confidence in applying innovative teaching methods (Kim & Kim, 2022; Lu et al., 2024). Taken together, these trends and gaps underscore the need to investigate how early-career teachers (ECTs) engage with GenAI in lesson planning.

Study Purpose

Recent national guidance emphasizes the need for educators not only to understand the presence of AI in education but to engage with it in informed and purposeful ways. The U.S. Department of Education's Office of Educational Technology (2023) suggested that AI in education efforts should focus on the alignment of AI models to educational goals and researched-based best-practices. Further, they recommended that institutions, "prepare teachers to integrate technology more systematically into their programs; ...not an issue that arises only in one course" (p. 59). Similarly, Trust et al. (2023) argued that teacher preparation programs should provide future teachers with opportunities to critically examine and engage with AI technologies, enabling them to make informed, evidence-based decisions about their use in education.

Despite these calls to action, research indicates that ECTs' knowledge and skills related to AI integration remain underdeveloped. Celik (2023) found that "little is known about teachers' knowledge and skills to integrate AI-based tools" (p. 9), while Kim and Kim (2022) and noted that few studies have examined the perceived usefulness and implementation of GenAI tools among early career educators. Together, these findings underscore a pressing need to explore how future teachers, in this case early-career science teachers, are beginning to engage with GenAI technologies in practice, particularly in contexts where lesson design and planning are central to instruction.

This exploratory study examined how ECTs enrolled in a STEM methods course during the fall 2023 semester integrated GenAI technologies into their lesson planning, as well as the factors influencing their acceptance and use of GenAI tools. Guided by a descriptive, noninferential approach, this study sought to identify patterns, trends, and relationships related to GenAI use without drawing causal inferences.

Because lesson planning forms the foundation of effective teaching, understanding the ways new AI technologies are being interpreted and applied by emerging educators is essential to informing teacher preparation, supporting responsible innovation, and enhancing future

educational outcomes. Toward this aim, this study asked the following questions:

1. How do early-career teachers in a STEM methods course (majority science) rate their pedagogical knowledge (PK), pedagogical content knowledge (PCK), and technological pedagogical content knowledge (or technology, pedagogy, and content knowledge [TPACK]) levels before and after completing the course with GenAI integration?
2. To what extent are GenAI tools being used in the creation of lesson plans, and what factors influence teachers' decisions to use or not use these tools?
3. Which GenAI tools are most commonly used in lesson plan creation, and for what specific tasks or components are they considered most useful?

Conceptual Framework

This study was grounded in theoretical constructs found in two frameworks, TPACK and the Technology Acceptance Model (TAM). TPACK provides a lens for understanding how teachers integrate technological knowledge into their pedagogical and content knowledge when designing lesson plans with AI tools. Rather than addressing skills in isolation, the framework focuses on the interplay among what is being taught (content), how it is taught (pedagogy), and how teachers use tools (technology; Koehler & Mishra, 2009).

PK is a general form of knowledge that applies to teachers' knowledge of student learning. Building off Shulman's (1986) initial framework, PCK focuses on how the "teacher interprets the subject matter, finds multiple ways to represent it, and adapts and tailors the instructional materials to alternative conceptions and students' prior knowledge" (Koehler & Mishra, 2009, p. 64). Altogether, TPACK is a complex interplay of technology, pedagogy, and content knowledge, and the implementation varies greatly among teachers.

Alongside TPACK, TAM offers insight into the motivational and behavioral dimensions that influence teachers' use of GenAI tools. TAM is one of the most widely applied frameworks for understanding users' acceptance and adoption of technology. TAM posits that an individual's behavioral intention to use a technology is influenced primarily by two factors: perceived usefulness and perceived ease of use (Marangunić & Granić, 2015; Venkatesh & Davis, 2000). Perceived usefulness refers to the extent to which a user believes that using a particular technology will enhance their performance or productivity. Perceived ease of use, on the other hand, refers to the degree to which a user believes that interacting with the technology will require minimal effort. Both factors work together to shape a user's intention to adopt and engage with new technologies (Joo et al., 2018).

In educational contexts, TAM has been extensively applied to examine the acceptance of a variety of digital learning tools. Research has investigated

its utility in understanding the adoption of e-learning platforms by teachers and students (Prasetyo et al., 2021), learning management systems (Shroff et al., 2011), educational wikis (Mohammadi & Mahmoodi, 2019), and virtual computing environments (Konak et al., 2017). More recently, TAM has been utilized to investigate the acceptance of chatbots and AI-driven educational technologies, revealing that both perceived usefulness and ease of use significantly impact educators' and learners' willingness to engage with these tools (Chocarro et al., 2023; Damiano et al., 2024; Teo, 2011).

Extensions of TAM in educational research suggest that contextual factors, such as prior experience with technology, professional development, and institutional support, also influence adoption behaviors (Liaw, 2008; Sun & Zhang, 2006; Teo, 2011). Professional development opportunities, in particular, have been shown to strengthen teachers' self-efficacy and positively influence both perceived usefulness and ease of use of AI-based tools (Kim & Kim, 2022; Lu et al., 2024). Conversely, barriers such as ethical concerns, technical challenges, or increased workload may reduce the perceived ease of use or usefulness of these tools, thereby impacting teachers' decisions to adopt GenAI in lesson planning (Chounta et al., 2021; Zawacki-Richter et al., 2019).

Applying TPACK and TAM to the present study provided a lens for understanding how ECTs in a STEM methods course approached integrating GenAI tools into their lesson planning. Teachers' perceptions of GenAI's usefulness in enhancing instructional design, coupled with their beliefs regarding the ease with which these tools can be implemented, can influence their behavioral intention to adopt them. For instance, if a teacher perceives that GenAI can efficiently generate lesson objectives, rubrics, or instructional materials and finds the technology straightforward to use, they are more likely to incorporate it into their planning practices.

Methods

Research Design

This study employed an exploratory, descriptive research design to examine how ECTs enrolled in a STEM methods course integrated GenAI tools into their lesson planning and the factors influencing their adoption and use of these tools. All procedures were approved by the university's Institutional Review Board. According to Swaraj (2019), an exploratory study is a "preliminary study of an unfamiliar problem about which the researcher has little or no knowledge" (p. 665). Particularly, exploratory studies are not intended to be confirmatory, but rather to be open and somewhat unstructured, while being guided by frameworks (Burton, 1979). This study focused on identifying patterns, trends, and relationships in teachers' perceptions, experiences, and behaviors, without attempting to establish causal relationships.

Research Team Positionality

The first author served as the instructor of the STEM methods course in which participants were enrolled. This dual role as instructor and researcher provided an insider perspective on the course content, pedagogical strategies, and participants' engagement with GenAI tools. While this positioning allowed for rich observational insight and contextual understanding, reflexivity was maintained to minimize potential bias in data interpretation. The second and third authors are STEM education researchers and practitioners who assisted in the data analysis, development of findings, and interpretation of results. Their external perspective helped ensure rigor and clarity in analyzing participants' experiences with GenAI tools in lesson planning.

Participants

The study included nine ECTs enrolled in the STEM methods course during the fall 2023 semester in the southeastern United States. Participants included two mathematics teachers and seven science teachers, all in the early stages of their teaching careers and serving as teacher candidates during a practicum experience or as full-time teachers seeking licensure through a graduate program. For consistency and clarity, both groups are referred to as ECTs in this study. Participants were purposefully sampled during course enrollment, representing early adopters of instructional technology in STEM education. A description of participants can be found in Table 1.

Context

The STEM teaching methods course was delivered synchronously online in fall 2023, with students meeting with the instructor on a weekly basis for 3 hours each week. The course focused on supporting students in developing both pedagogical knowledge and skills in technology integration, including modules in the following areas: project-based learning, culturally sustaining pedagogy, the role of technology in STEM teaching and learning, assessment, and design-based unit and lesson design (Smith-Mutegi, 2026). During the course, the instructor curated and demonstrated select GenAI tools to support 5E lesson planning (Bybee et al., 2006), promote the development of TPACK, and encourage reflective use of GenAI in lesson design.

Considering the recent release of ChatGPT during the timeframe of this course, activities included the guided exploration of GenAI tools, integration of AI in lesson planning tasks, and structured reflection on the effectiveness and usability of these tools. GenAI tools were introduced as an additional layer of instructional support rather than a requirement. The instructor modeled and demonstrated the use of the following: MagicSchoolAI, ChatGPT, Gemini, Perplexity, and Curipod. She also facilitated class discussions on new AI capabilities in tools like Canva, and the online assessment platform formerly known as Quizziz.

Table 1
Participant Demographics

Participant	Program	Disciplinary Focus	Placement During the Course
1	MAEd	Middle School Science	Full-time teacher
2	MAEd	Chemistry	Practicum placement
3	Licensure only	Middle School Science	Full-time teacher
4	MAEd	Biology	Practicum placement
5	MAEd	Biology	Full-time teacher
6	MAEd	Biology	Practicum placement
7	Licensure only	Middle School Math	Full-time teacher
8	MAEd	Math	Practicum placement
9	BA	K-6 Science	Practicum placement

To demonstrate the use of GenAI tools, the instructor introduced students to the practice of prompt engineering. For example, students learned how to support the needs of diverse students through the Universal Design for Learning (UDL) framework. To support the integration of UDL, the instructor modeled a prompt inquiry on ChatGPT using the following scaffolding:

1. Who: Share who you are (e.g., I am a High School Biology teacher...).
2. What: Share what you want your product to be (e.g., please help me design a lesson that features multiple representations for a Biology lesson plan on cell theory).
3. How: Share the standard or core principle you want to teach (e.g., aligned to this standard...).
4. Why: Share why you would like the support (e.g., to support the diverse learners in my classroom, including various ethnic backgrounds and academic abilities).

After demonstrating each tool, the instructor gave students time to practice and discuss. The instructor asked students to compare the outputs with other GenAI tools, including Perplexity and Gemini. Examples of other inputs and outputs can be found in Smith-Mutegi and Crisden (2025). Figure 1 provides an example of a slide deck presented in class, highlighting some of the various tools discussed.

Figure 1
Example of GenAI Tools Demonstrated in Class



Data Collection

Data were collected using a combination of quantitative and qualitative instruments, including a (a) Pre/Post TPACK Survey based on Schmid et al.'s (2020) validated short assessment, which measured teachers' self-perceived technological, pedagogical, and content knowledge before and after completing the course, a (b) Pre/Post AI Perceptions and Experience Questionnaire, which assessed participants' familiarity with GenAI tools, perceptions of usefulness and ease of use, and confidence in integrating AI into lesson planning, and a (c) AI Tool Utilization Questionnaire, which was administered three times following each lesson plan submission to document which GenAI tools were used, for which specific tasks, and to capture short-answer reflections on the perceived benefits and challenges of each tool. This form received 24 responses across three administrations, whereas the pre and post instruments received nine responses each during each administration.

Data Analysis

Quantitative data from the TPACK and AI perception surveys were analyzed using descriptive statistics, including means, standard deviations, and frequency distributions, to identify patterns and changes over time, from the beginning to the end of the semester. Qualitative data from open-ended responses to AI tool utilization and experience questionnaires were analyzed using thematic analysis, which involved iterative coding to identify common themes, patterns, and insights related

to tool use, pedagogical application, and perceived barriers and facilitators. Triangulation of quantitative and qualitative data strengthened the trustworthiness of the findings and provided a holistic understanding of how ECTs engaged with GenAI tools during lesson planning.

Findings

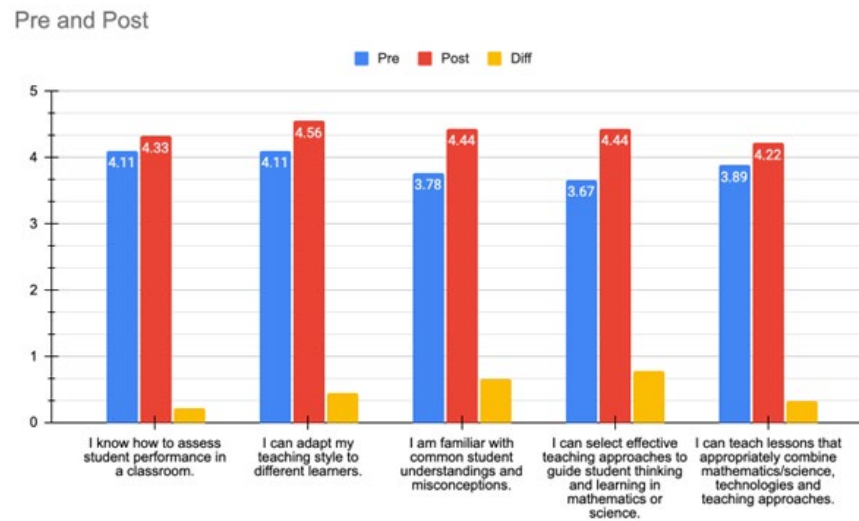
This exploratory study sought to answer three specific questions: (a) How do early-career teachers in a STEM methods course (majority science) rate their PK, PCK, and TPACK levels before and after completing the course with GenAI integration? (b) To what extent are GenAI tools being used in the creation of lesson plans, and what factors influence teachers' decisions to use or not use these tools? and (c) Which GenAI tools are most commonly used in lesson plan creation, and for what specific tasks or components are they considered most useful? The results of these questions are presented here as three themes.

Growth in Pedagogical and Technological Knowledge

ECTs demonstrated measurable growth in PK, PCK, and TPACK throughout the STEM methods class. This growth was captured through pre- and postcourse survey data (see Figure 2), which showed positive shifts in participants' self-assessed competencies. Participants reported a slight increased confidence in their ability to integrate technology into instructional practices, particularly in ways that supported lesson planning and design. The largest difference was found with selecting effective approaches to guide students' thinking in their disciplinary areas. This development was likely facilitated by the course's structured approach to integrating technology and GenAI. Participants engaged in guided exploration of GenAI tools, completed reflective assignments, and received instructional modeling that emphasized both pedagogical application and ethical considerations. These activities created a supportive learning environment that encouraged experimentation and critical engagement with emerging technologies.

The observed increases in PK, PCK, and TPACK aligned with TAM, which supports that users' intention to adopt technology was influenced by perceived usefulness and perceived ease of use. In this study, professional development played a central role in shaping these perceptions. As participants gained hands-on experience with GenAI tools, they began to view them as both valuable and manageable within the context of lesson planning. This shift in perception likely strengthened behavioral intentions to incorporate GenAI into their teaching practices.

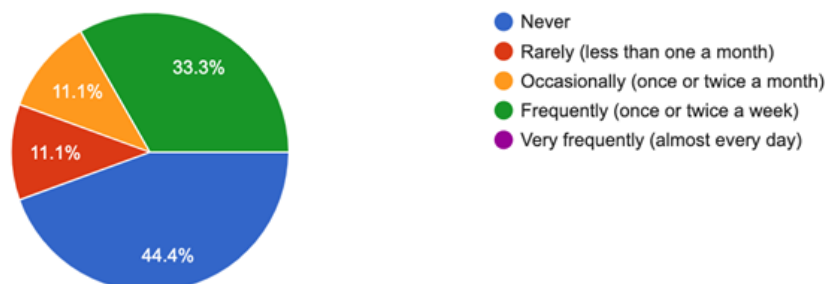
Figure 2
Pre and Post TPACK Survey Results



Increased Exposure to GenAI Tools Promoted Utilization

Throughout the fall 2023 semester, ECTs demonstrated a clear evolution in their engagement with GenAI tools. At the beginning of the course, participants approached GenAI cautiously. As shown in Figure 3, most ECTs estimated that they rarely or never utilized GenAI tools for lesson planning tasks, while 33% stated that they used GenAI tools once or twice a week. Those who used GenAI tools cited tools such as Grammarly, Khan Academy, Quizlet, and Desmos, which were used mainly for grammar correction, paraphrasing, and content reinforcement. These selections reflect a preference for familiar, low-risk applications of AI, often used to support rather than drive instructional design.

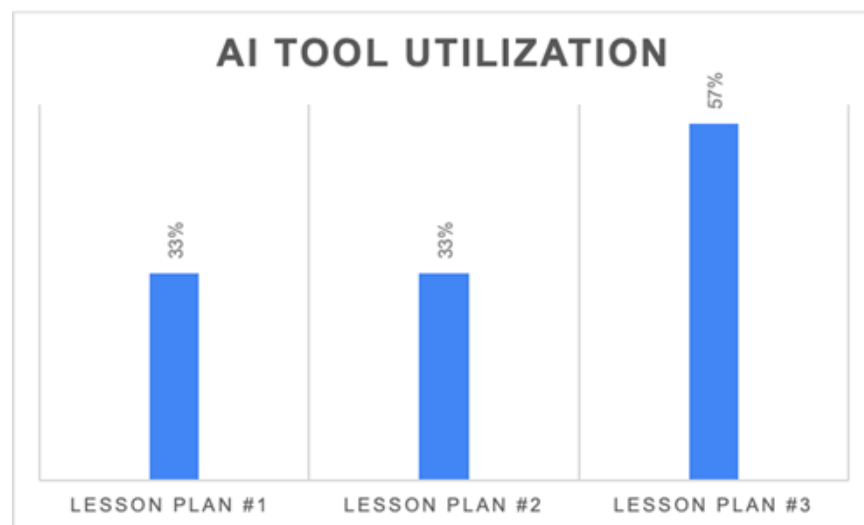
Figure 3
Beginning of Semester AI Tool Utilization (N = 9)



Throughout the semester, ECTs were exposed to several GenAI tools during course lectures and meeting times. After each lesson plan submission, teachers responded to the AI utilization survey to describe their use of the AI. From the first to the third lesson plan submission, ECTs reported an overall increase in their use of the tool to support lesson planning (Figure 4). When participants were asked how they used the selected tools, they reported using them for lesson structuring, assessment creation, brainstorming, and generating ideas for student engagement. Additionally, participants cited the use of AI for checking errors in typing early on, noting “it corrected spelling mistakes and incorrect tenses in English.” By the end, for the third lesson plan, participants cited uses for differentiation and content research, among others.

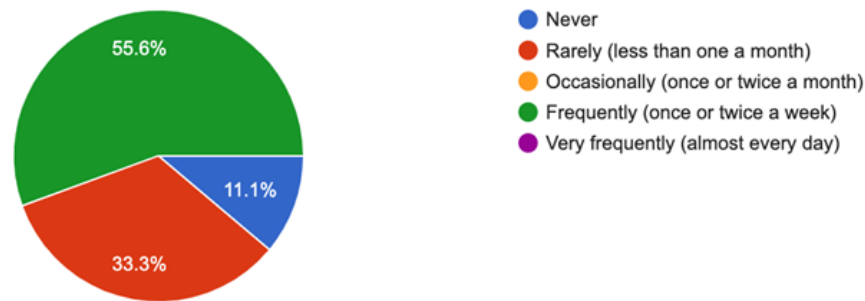
Figure 4

AI Tool Utilization With Lesson Plan Development



By the end of the semester, on the AI Perceptions and Experience Questionnaire, more than half of the ECTs reported frequently utilizing GenAI tools (Figure 5), up from the previously reported one third of teachers at the beginning of the semester, while only one ECT (11.1%) stated that they never utilized AI for planning. Further, ECTs reported increased engagement with more sophisticated GenAI platforms, including MagicSchoolAI and ChatGPT. These tools were used for a broader range of instructional tasks, including assessment creation, rubric development, and lesson objective generation, and this use increased over time. This shift in both tool preference and application suggests growing familiarity and confidence in using GenAI for pedagogical design.

Figure 5
End of Semester AI Tool Utilization (N = 9)



This progression aligned closely with TAM, in that users' behavioral intention to adopt technology was shaped by two primary factors: usefulness and ease of use. In this study, increased exposure to GenAI tools, through structured course activities and reflective practice, appears to have enhanced both. As participants became more comfortable navigating GenAI platforms and recognized their instructional value, their willingness to integrate these tools into lesson planning increased. This suggests that intentional, scaffolded exposure to GenAI tools in teacher preparation programs can foster meaningful adoption. When ECTs are supported in exploring AI technologies in low-stakes environments, they are more likely to perceive these tools as applicable and manageable, thereby increasing their likelihood of sustained use in professional practice.

Pausing for Thoughtful Integration of AI

As ECTs explored GenAI tools during the STEM methods course, their decisions to adopt or avoid these technologies were shaped by a range of pedagogical, contextual, and ethical considerations. One ECT noted on the presurvey, "I am anti AI but interested in hearing the benefits," emphasizing their reluctance while also showing openness to learning more. These findings suggest that GenAI integration is not simply a matter of access or exposure, but a process that requires thoughtful reflection, trust, and alignment with instructional goals.

Participants who engaged with GenAI tools identified several affordances that supported their lesson planning. Tools such as MagicSchoolAI and ChatGPT were utilized to create assessments, develop rubrics, and generate lesson objectives. These applications were perceived as useful for streamlining instructional tasks and saving time on lesson design, thereby improving efficiency. GenAI also served as a cognitive partner in brainstorming, helping teachers generate ideas even when the AI tool's suggestions were not directly implemented. One participant said, "It got me thinking and unstuck. Nothing like seeing ideas you don't like to get you working on ideas you do!" They cited the usefulness of outputs from the GenAI tool in moving along their ideas. Another participant explained, "I used it for brainstorming. I didn't really like any of the specific

suggestions, but thinking through it got me moving and gave me ideas for things I did like.”

Table 2 provides frequency counts summarizing the benefits and challenges of AI tools as noted by participants in the postsurvey, highlighting the role of GenAI in enhancing STEM lesson planning. Notably, GenAI tools were frequently used as brainstorming aids rather than as sources of finalized content. This comment illustrates how even limited interaction with GenAI can stimulate instructional ideation, supporting TAM’s assertion that perceived usefulness may extend beyond direct output to include cognitive support in planning.

Table 2
Summary of Perceived Benefits and Challenges of Using AI Tools in Education

Benefits	Benefit Frequency	Challenges	Challenge Frequency
Saving time and effort	6	Lack of trust or reliability	5
Generating creative and innovative content	6	Ethical or legal issues	4
Enhancing student engagement and motivation	4	Lack of training or guidance	3
Improving communication and collaboration	2	Pedagogical or curricular alignment	2
Providing personalized feedback and support	1	Privacy or security concerns	2
Developing critical thinking and problem-solving skills	1	Student misuse (cheating)	1

Not all participants chose to integrate GenAI into their lesson planning. Several participants noted that they “found it unnecessary.” Further, several ECTs paused or opted out of using GenAI tools due to concerns about accuracy, ethical implications, or the availability of existing resources. Several participants chose not to incorporate GenAI tools into their lesson planning, and their reasons reflected thoughtful consideration of their existing instructional contexts. One ECT explained, “My lesson plan was one I have been using prior to this class,” suggesting that the familiarity and effectiveness of previously developed materials reduced the perceived need for AI-generated content. Another participant noted, “The main reason is I have materials provided by my school district,” indicating that institutional resources already met their planning needs.

Mentor influence also played a role, as one teacher said, “The worksheets are from my mentor teacher, and I liked the idea behind the worksheets,” highlighting the value placed on trusted, human-generated materials. Even among those who experimented with GenAI, some remained hesitant to fully integrate its suggestions. As one participant reflected, “I did use it, but I didn’t incorporate a lot of ideas because I already had some of my own.” These responses demonstrate that decisions regarding AI integration are influenced not only by technical capabilities but also by professional relationships, instructional confidence, and trust in the reliability of AI outputs.

Furthermore, these reflections underscore the significance of contextual factors, including institutional norms, mentorship, and curriculum constraints, in influencing technology adoption. They also emphasize the importance of trust in determining whether AI-generated content is perceived as reliable and pedagogically sound.

Discussion

This study examined how ECTs in a STEM methods course interacted with GenAI tools, focusing on their perceptions, usage patterns, and the factors influencing their adoption. Across the semester, participants demonstrated growth in both PK and TPACK. This growth suggests that even limited, structured exposure to GenAI tools can enhance ECTs’ confidence and competence in using technology to support instructional design. The course’s emphasis on guided exploration and practice appeared to foster meaningful engagement, aligning with TAM’s assertion that professional development, even through coursework, has a positive influence on technology adoption (Guggemos & Seufert, 2021).

Patterns of GenAI technology use evolved. At the beginning of the semester, participants engaged cautiously, using familiar tools for grammar correction and content reinforcement. By the end of the course, more sophisticated platforms were used for assessment creation, rubric development, and lesson structuring. However, not all participants chose to integrate GenAI into their lesson planning. Reasons for nonuse included reliance on district-provided materials, mentor teacher resources, and concerns about the accuracy and ethical implications of AI-generated content. It is not surprising that participants may have been concerned with the risks associated with GenAI tools, as earlier reports of AI hallucinations and inaccuracies may have contributed to the fear or mistrust of the outputs. Further, it is well established that GenAI tools can also produce scientifically inaccurate explanations, literature citations, or mathematically inaccurate solutions (Walczak & Cellary, 2023). These risks create another layer of pedagogical responsibility, whereby ECTs not only integrate AI purposefully but must also determine if the content produced by GenAI is accurate. These barriers highlight the importance of trust and contextual relevance in shaping technology adoption. Therefore, developing ECTs’ capacity to integrate and utilize GenAI tools emerges as a critical component of STEM teacher education.

Even among those who experimented with GenAI, some paused to reflect on whether the tools aligned with their instructional goals and values, a process that stressed the need for thoughtful, rather than automatic,

integration. Importantly, this pause was not always a rejection; it was often a moment of thoughtful consideration. ECTs weighed the benefits of GenAI against their professional values, instructional goals, and classroom realities.

ECTs are constrained by several factors, including mentor teachers, K-12 district-level policies, and the mandatory implementation of district-level instructional materials (Roegman & Kolman, 2019). This suggests that successful AI integration in education requires more than technical training; it demands space for reflection, ethical dialogue, and pedagogical alignment. Further, this study highlights the tensions often found between university innovation and the constraints of the K-12 classrooms (Phelps, 2019; Thornton, 2021). The decision to use GenAI tools was not a binary one, but rather nuanced.

ECTs engaged in a process of discernment, striking a balance between innovation and caution. In a recent study on AI in teacher education, Aleman et al. (2025) suggested that AI literacy requires not only technical knowledge but also critical literacy, in which educators must weigh the cultural, ethical, and political implications of AI integration. As educational institutions continue to introduce AI technologies, they must also create conditions that support thoughtful integration, where ECTs feel empowered to explore, question, and selectively adopt tools that align with their practice and comfort levels.

Study Limitations

While offering valuable results to the field, this study also had several limitations. First, the small sample size ($N = 9$) and single-course context limit the generalizability of findings beyond similar STEM teacher preparation settings. Because the cohort included two mathematics ECTs and the sample size was small, disciplinary differences were not examined separately. Second, data relied primarily on self-reported survey responses, which may be subject to social desirability bias, particularly given the professional expectations surrounding technology integration and AI use. Although participants were encouraged to respond honestly, responses may reflect perceived appropriate practices rather than actual behaviors.

Third, the course instructor also served as the first author of the manuscript and lead researcher, which may have influenced participants' responses, despite assurances that survey data would not affect course standing. Accordingly, findings should be interpreted as exploratory and reflective of participants' reported perceptions rather than observed practice. Further, as an exploratory investigation, this study was not intended to yield generalizable conclusions; instead, the findings offer initial insights that warrant further examination in larger and more diverse contexts.

Implications for Practice

The findings suggest that teacher preparation programs must go beyond introducing GenAI tools. Rather, they must also create conditions for critical engagement with these tools. ECTs need opportunities to explore

AI technologies in low-stakes environments, reflect on their pedagogical fit, and discuss ethical considerations such as data privacy and academic integrity. Cooper et al. (2025) suggested that teacher preparation programs may need to adopt new pedagogical frameworks to address the added challenges of integrating emerging technologies, such as GenAI.

Further, professional development should be ongoing, responsive, and embedded within authentic instructional contexts. In response to this need, some teacher preparation programs are beginning to design AI-focused courses and instructional modules that provide teacher candidates with foundational knowledge of artificial intelligence and practical strategies for responsible classroom integration (International Society for Technology in Education, 2023). Additionally, efforts in educator preparation should emphasize the expectation that candidates demonstrate competencies in AI literacy, including ethical use, bias awareness, and instructionally sound application of AI tools (Dilek et al., 2025; Holmes et al., 2019).

Moreover, the study supports the importance of trust in AI systems. ECTs are more likely to adopt GenAI when they believe the tools are reliable, accurate, and aligned with their professional standards. Building this trust requires transparency in how GenAI tools function, as well as guidance on evaluating and adapting AI-generated content.

Conclusion

This study found that ECTs were more likely to use GenAI tools when they perceived them as useful, easy to use, and trustworthy. Professional development within the STEM methods course likely played a critical role in increasing utilization, while contextual factors such as existing resources and mentor influence shaped decisions to pause or reject AI integration. These findings affirm the relevance of the TAM in understanding the adoption of GenAI and highlight the need for thoughtful, reflective, and ethically grounded approaches to AI in education. To strengthen the generalizability of these findings, future research should include larger and more diverse samples across educational levels, disciplines, and geographic regions. Longitudinal studies could examine how GenAI adoption evolves over time and how sustained professional development influences usage patterns. Additionally, research should explore the impact of GenAI on student learning outcomes, classroom dynamics, and equity in access to instructional innovation.

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