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Research Article

Integrating AI tools into preservice mathematics teacher education: A qualitative study of lesson planning practices

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ABSTRACT

This study examined the participation of preservice teachers (PSTs) in artificial intelligence (AI)-generated lesson-plan training sessions, primarily within a mathematics instruction course in a teacher training program. Although earlier research has explored AI in education, few studies have specifically looked at how AI-generated lesson plans affect PSTs' lesson-planning skills. This study addresses this gap by exploring math PSTs' views on the use of AI-generated tools in lesson planning. Data were collected from focus group interviews with fifty students and were analyzed thematically using a coding framework after targeted training sessions. The findings revealed key themes, including the time-saving benefits of AI, its ability to produce innovative activities, and the support these tools provide to PSTs. While AI tools served as scaffolds, the importance of teacher agency, pedagogical knowledge, and content alignment remained vital. These results highlight the potential of AI support in teacher training programs, while also recognizing that it does not replace essential skills such as critical thinking and professional judgment. The study offers implications and recommendations for integrating AI while maintaining pedagogical rigor and curriculum integrity.

Keywords: artificial intelligence, preservice teachers, lesson planning, mathematics education, teacher training, pedagogical knowledge, higher education

INTRODUCTION

Integrating artificial intelligence (AI) into educational settings has become increasingly evident, and new tools have been adopted to transform teachers' teaching approaches. AI generative tools may restructure lesson planning, generate innovative teaching activities, and provide structured assistance to teachers in teacher-training programs or preservice teachers (PSTs), especially those new to the profession. Like any emerging technology, AI in education (AIEd) raises essential issues related to efficiency, challenges, and ethical concerns. This study contributes to the growing field of exploring AI and technology-enhanced learning in teacher education. To maintain this, it is essential to provide this technology. While previous research has explored the use of AIEd, few studies have examined the impact of AI-generated lesson plans on preservice mathematics teachers' lesson-planning skills and how they used AI to adopt and use these skills in their lesson preparation (Karaman, 2024). This study addresses this gap by investigating math PSTs' perspectives on the use of AI-generated tools in lesson planning. Observing the advantages and potential challenges of these tools may provide a deeper understanding of how to use innovative tools in education.

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LITERATURE REVIEW

Math Preservice Teachers and Training

PSTs are trained to create comprehensive lesson plans as part of their teacher preparation programs. Research shows that lesson planning is one of the most challenging skills for educators to master, as it demands significant time and effort (Sa'adah & Anjarwati, 2022). Several studies have supported this finding and highlighted lesson planning as a complex and demanding task for PSTs. For example, Fitriati et al. (2023) noted that even within structured training programs, PSTs need continuous practice to develop effective planning strategies. Similarly, Süral (2019) found that many PSTs have limited abilities in lesson planning, often struggling to align instructional goals with classroom activities. Hatch and Clark (2021) also demonstrated that lesson planning involves not only structuring content but also making subtle instructional decisions. Overall, this body of research confirms that lesson planning remains one of the most difficult skills for educators to master. These skills require both pedagogical knowledge and time-consuming preparation. Building on this understanding, preservice mathematics teachers face unique challenges as they must integrate complex mathematical content knowledge with effective pedagogical strategies to design meaningful lesson plans.

Furthermore, recent research highlights the importance of effective lesson planning in teacher-training settings, emphasizing its crucial role in teaching success (Alrwaished, 2024; Buchbinder & McCrone, 2020; Iqbal et al., 2021). Instructional success involves PSTs' ability to design lesson plans that align with curriculum standards, promote student engagement, and meet specific learning objectives (Buchbinder & McCrone, 2020; Iqbal et al., 2021). Teacher training programs aim to equip PSTs with essential knowledge, skills, and practical experience needed for effective classroom instruction. Essuman and Wilmot (2024) argued that mathematics PSTs must thoroughly understand complex mathematical concepts and effective teaching strategies to deliver precise and impactful lessons.

Artificial Intelligence in Teacher Education

AI has become a significant player in transformative education (Alasmari, 2025; Cooper, 2023). Integrating AI into education empowers teachers to create more personalized learning experiences that cater to students' needs (Luckin et al., 2022). Over the years, several scholars have presented considerable evidence of teacher training in technology and its impact on redirecting professional learning and instructional technology practices (Ayanwale et al., 2024; Zhang et al., 2023). AI is a branch of computer science that uses intelligent machines capable of mimicking human intelligence processes with in-depth precision and analytical reasoning. It can also simulate other methods, such as learning, reasoning, decision-making, problem-solving, and planning (Russell & Norvig, 2016). Simulations play a vital role in enabling educators to develop more effective teaching methods and enhance students' understanding of complex mathematical concepts (Alsaeed & Mohammad, 2023). AIEd, on the other hand, refers to the application of AI in educational settings to enhance learning and teaching practices (Wang et al., 2024). Research in this area stems from preparing teachers to integrate AI into STEM classrooms (Lee & Perret, 2022), utilizing chatbots in teaching (Chiu et al., 2023), and using AI for personalized learning (Tapalova & Zhiyenbayeva, 2022).

Recent research on teacher education and AI integration further highlights the importance of structured use of AI tools and teacher training. AI integration in higher education is also increasingly a focus worldwide. For example, a recent study by Vorobyeva et al. (2025) examined pedagogical approaches to AI tools that support personalized learning. They found that planning enhances personalization while still requiring teacher scaffolding. This demonstrates that AI will not replace teacher presence in the classroom. Another study by Abualrob (2025) explored how PSTs used AI tools to design science lessons. This study emphasized the value of prompt engineering and reflective practice in lesson creation. Additionally, Jantakoon et al. (2025) discovered that AI tools improved language instruction but need deliberate pedagogical alignment. Participants stressed the importance of aligning AI-generated content with curriculum goals and pedagogical intentions. Taani et al. (2025) also examined how AI tools influenced in-service teachers' self-regulation and autonomy. Their study revealed that exposure to AI tools promotes reflection and autonomy in lesson planning. Bora and Kölemen (2025) examined AI's role in instructional design in higher education and stressed the importance of integrating AI thoughtfully. Overall, these studies confirm the growing role of AI in teacher

preparation and emphasize the need for training models that combine technical skills with pedagogical judgment, which this study directly addresses.

Disadvantages of Using Artificial Intelligence in Teacher Training

Although the literature has provided many benefits of AI in teacher training, it also identifies several disadvantages (Ivanov, 2023). One apparent concern is that traditional teacher-training approaches require greater human interactions and social connections (Dimitriadou & Lanitis, 2023; Shah, 2023). Researchers argue that overreliance on AI applications may diminish interpersonal skills among teachers and students, potentially hindering the development of deeper connections with students (Van den Berg & du Plessis, 2023). Another documented challenge was the inadequate trustworthiness of trust in algorithm reliability, technical capacity, and infrastructure; teachers' lack of technical knowledge when using AI; and issues with AI in assessments and evaluations, among others (Celik et al., 2022, p. 624). Other challenges include ethical considerations regarding data privacy, algorithm bias, and moral engagement (Shah, 2023; Vorobyeva et. al., 2025). Consistent with this, Vorobyeva et al. (2025) argued that there are ethical implications central to any educational practice, including bias, transparency, and data privacy. They argue that human interactions are crucial to ensure that AI tools do not compromise learning environments, thereby maintaining equity and autonomy in these spaces. These arguments can also be applied equally to teacher training programs, as overreliance on AI-generated tools may compromise pedagogical integrity if not thoroughly examined.

The Role of Artificial Intelligence in Lesson Planning from the Viewpoint of Constructivism

According to Van den Berg and Du Plessis (2023), AI can analyze multiple sources to provide feedback on the effectiveness of lesson plans. This can help PSTs make data-driven decisions regarding teacher education. They argued that AI-generated lesson planning can make lessons more applicable by suggesting resources, student activities, and assessments aligned with curriculum standards. Karaman (2024) argued that AI tools create tailored experiences based on students' interests. This highlights the potential of AI-generated tools to reduce workload, thereby relieving PSTs of a significant stressor. Studies by Mon et al. (2023) and Karman (2024) revealed that most teachers were confident in their planning abilities after employing AI tools. AI tools provide templates and feedback, enhance pedagogical reasoning skills, and enable PSTs to create more efficient learning experiences. The current study on PSTs' use of AI tools can be viewed constructively. Constructivism holds that learners construct knowledge through experience and reflection (Vygotsky, 1978). The PSTs adapt and modify AI-generated lesson plans to build an understanding of the pedagogy. This approach emphasizes the nature of learning and its importance in shaping pedagogical practices.

METHODOLOGY

The current study employed qualitative methodologies, including theme analysis and in-depth focus group (FG) interviews, to explore teachers' perspectives on AI-enhanced lesson-planning tools. Furthermore, a descriptive-qualitative approach was employed to gain a comprehensive understanding of the study's objectives (Cohen et al., 2017; Lichtman, 2023). The researchers collected data in phases, both during training and after, using FG interviews (see **Appendix A**). Artifacts, including lesson plans and AI-generated lesson plans, were collected from the PST teachers. This allowed the researchers to better evaluate participants' insights into using these tools across all phases. Hatch (2023) emphasized that artifacts in qualitative research can serve as secondary data sources, providing additional information and insight. Thus, this study seeks to answer the following questions:

1. What are PSTs' perspectives on lesson plans generated by AI tools?
2. What are PSTs' perspectives on the benefits of AI for lesson planning?
3. What challenges do math PSTs face when using such AI tools?

Study Participants

The target study group consisted of elementary mathematics professional teaching standards enrolled in a three-credit course on mathematics teaching methods at a college of education in a Middle Eastern country.

Table 1. Demographics

PSTs demographics	Fifty PSTs enrolled in the mathematics teacher training program
Class	Classroom 1: 27 students & classroom 2: 23 students
Gender	31 female students & 19 male students
Academic year	3rd year and 4th year students

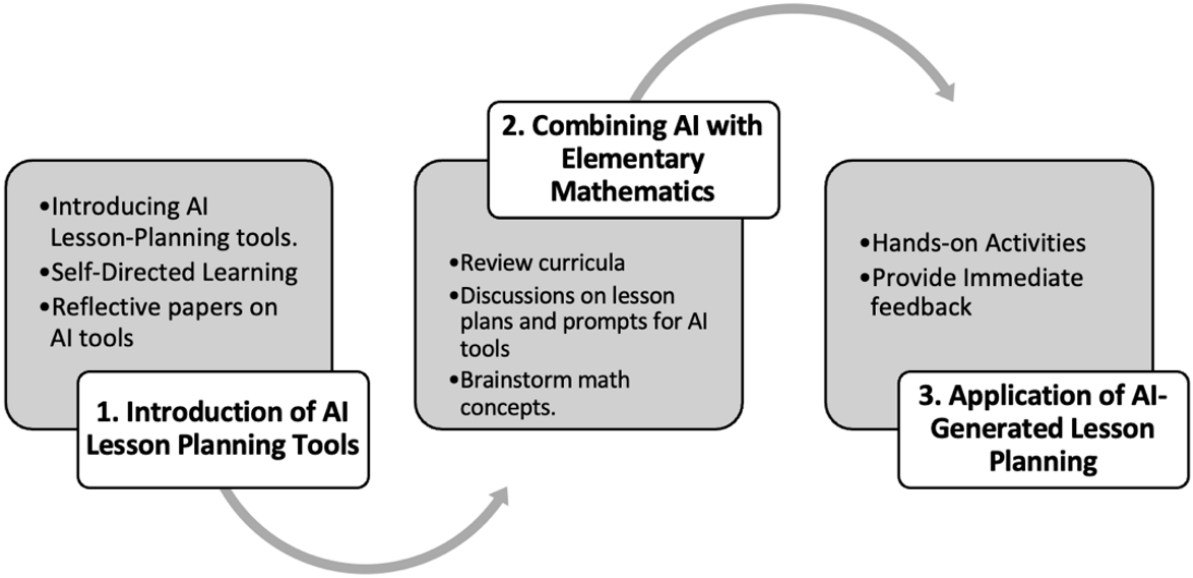


Figure 1. Phases of training sessions for AI-generated instruments (Source: Authors)

Fifty PSTs from two classes participated in the study. Demographic and student information are presented in **Table 1**.

Training Session

PSTs participated in activities aimed at developing essential 21st century skills, as shown in previous studies (Langran et al., 2024). The training materials were created using various AI tools that enhance lesson planning by focusing on materials and activities based on core theories of 21st century skills, thereby enriching the training sessions (Escotet, 2023; Okagbue et al., 2023). Throughout the training, AI tools played a vital role beyond just initial intervention development. PSTs used AI to generate lesson objectives, sample activities, worksheets, and evaluation ideas aligned with the mathematics curriculum. These tools also offered different instructional strategies, which participants compared with their own lesson plans to evaluate and enhance both AI-generated and self-created materials. For example, these AI tools helped develop scaffolding questions and problem-solving prompts. They also assisted in producing worksheets and activity ideas suitable for classroom use. By integrating these tools into practical exercises, the training emphasized not only lesson plan design but also the critical evaluation of AI outputs. These tools also allow adaptation to specific contexts and their application in real classroom settings. This approach ensured that AI served as a support tool to improve pedagogical design rather than merely being a content generator.

It is important to note that the participants had previously completed courses in computer education, instructional media, technology, foundational mathematics, and science and mathematics curricula, equipping them with the essential skills needed to prepare for AI training. They also have the knowledge to develop effective lesson plans using traditional methods. Additionally, prior research by AlSuwaihel (2024) established that PSTs in Kuwait are generally proficient with technology, supporting the assumption that participants in the current study entered the training with a basic level of technological competence. Furthermore, the researchers consulted a team of experts from diverse backgrounds to enhance teachers' lesson plans through AI tools. The training materials were reviewed, approved, and endorsed by two elementary school math teachers and two instructional technology professors to ensure relevance to the current context. This study presents a model for teacher training that can be adapted to various teaching environments, not just for mathematics PSTs. **Figure 1** summarizes the training sessions.

Training Session Phases

Overview of artificial intelligence-based lesson planning resources

The first phase provided an overview of AI-enhanced lesson-planning tools, drawing from various sources, including journals, online tools, and web or mobile applications. This section explained the history of these tools and their advantages to educators.

Combining artificial intelligence with elementary mathematics

This phase involved using mathematics textbooks from public schools as references. The textbooks contain the curriculum and outdated lesson plans from a previous teacher. Some included example lessons, which PSTs analyzed to gain an understanding of instructional design approaches. They then adapted these examples into their own lesson plans and later improved them with AI tools. The PSTs reviewed these textbooks and selected lessons to help students develop their teaching skills. They were also asked to examine the teachers' lesson plans to understand how they might create or improve them. To guarantee the quality and relevance of the training, the researchers engaged two groups of experts. First, two experienced elementary mathematics teachers reviewed the lesson content to verify its alignment with curriculum standards and its reflection of classroom realities. Second, two instructional technology professors assessed the AI-driven training activities and offered guidance on incorporating interactive digital tools and strategies to enhance pedagogical effectiveness. These experts collaboratively helped improve the training sessions by validating curriculum relevance, confirming the suitability of AI outputs, and ensuring the model's effective application in mathematics education and adaptability to other teaching contexts.

Application of artificial intelligence generative tools

During the final phase, several AI tools were used to demonstrate this, allowing students to create and access lesson plans more easily when teaching. The PSTs can upload the national curriculum and lesson plans to the AI tool and software. Training involves teaching PSTs the essential skills needed to use the tool effectively and achieve the best results. The main goal is to focus on precise prompts to develop a complete lesson plan. Examples of these prompts are as follows:

1. AI, please provide three lesson objectives using this terminology …
2. Provide resources, worksheets, and tools used to complete this lesson
3. What fun activities can I do with my students when teaching this mathematical concept?

They then compared their lesson plans with those generated by AI. These phases were divided into five weeks. Each week, different skills were provided during training to enhance and create lesson plans using AI-generated tools. The researchers guided participants through workshops using these tools to develop effective lesson plans. This phase concluded by ensuring that the PSTs demonstrated their understanding through reflective writing. **Table 2** provides a detailed explanation for each week. Frequently in teacher training, lesson planning often involves a specific, domain-specific pedagogical framework. One framework is the *pedagogical content knowledge*, which emphasizes the importance of effective teaching strategies and a deep understanding of subject matter (Depaepe et al., 2013). When it comes to mathematics education, this encompasses mathematical knowledge for teaching, which includes understanding content knowledge and teaching strategies specific to mathematics (Pincheira & Alsina, 2021). The purpose of these frameworks is not only to help PSTs develop lesson content, but also to analytically evaluate learners' needs, considering students' levels, backgrounds, and context, and to differentiate instruction to meet those needs. Therefore, future teacher training programs must incorporate prompts, scaffolding, and information that reflect these frameworks to support PSTs both technologically and instructionally.

The AI training was organized into three stages, as shown in **Table 2**. In the first stage, PSTs were introduced to AI tools and shown how they could develop lesson objectives and sample activities aligned with the mathematics curriculum. During the second stage, participants practiced using tools such as Alyana AI, ChatGPT, MagicSchool, and Canva AI to design lesson components. They compared the AI-generated outputs with their own ideas. The final stage emphasized reflection, where PSTs revised their lesson plans with expert feedback and discussed ethical and pedagogical considerations for future classroom use. This approach

Table 2. Training intervention

Weeks	Phase	Tools, articles, & resources
1 six hours	Phase 1. Overview of AI in education ▪ An overview of AI tools and applications in education (Alyana AI, ChatGPT, Canva AI, and magic school AI) ▪ Lesson-planning guidelines and steps ▪ Choosing a topic, or lesson from the curriculum	▪ AI applications such as ▪ Curriculum: public school math textbooks ▪ Journal articles
2 six hours	Phase 2. Practice ▪ Brainstorming ▪ Practice: using public school curriculum, use AI tools to create lesson plans that meet educational standards	
3 six hours	Phase 3. Presenting findings ▪ Present lesson plans to their peers and provide potential troubleshooting solutions	
4 six hours	Phase 4. Reflective paper ▪ A reflective paper	
5 six hours	Phase 5. Interview and discussion ▪ FG Interviews	

Table 3. FG interview distribution

FG	Number of students	Duration
FG A	1-10	55 minutes
FG B	11-20	50 minutes
FG C	21-30	63 minutes
FG D	31-40	60 minutes
FG E	41-50	55 minutes

ensured that the training went beyond introducing participants to tools, helping them learn to critically evaluate and adapt AI outputs for educational purposes.

Although the training was designed for using AI with mathematics PSTs, the model can be adapted to other teaching contexts and subject areas by replacing discipline-specific curricula, examples, and lesson goals. For instance, language PSTs could follow the same stages: introducing AI tools, incorporating them into subject-based lesson planning, and reflecting on their application in learning English, Arabic, or other languages by searching for subject-specific lesson plans and customizing them to fit their own institutional setting and specific learning objectives.

Information Gathering and Data Analysis

The PSTs participated in in-depth FG interviews after training sessions. Open-ended questions enable a more in-depth examination of their thoughts and insights, providing well-rounded qualitative research (Lichtman, 2023). Wilson (1997) asserted that FGs are essential for providing an in-depth understanding of perceptions, challenges, and insights into a particular environment. Lindlof (2009) states that utilizing FGs facilitates the verbalization of experiences and clarifies beliefs, opinions, and attitudes regarding a specific topic. Hence, questions were formulated to focus on PSTs' responses regarding the uses, benefits, and challenges of using AI in their lesson planning. The twelve-question interview centered on AI-enhanced lesson-planning tools (see **Appendix A**). Three AI experts reviewed the questions and provided valuable feedback to enhance them. Subsequently, changes were made in response to the feedback. PSTs were encouraged to provide thorough justifications and examples during the interviews. The researchers conducted 50- to 60-minute FG interviews with the participants, arranging the time according to their availability. This resulted in five FG sessions, including fifty students, as shown in **Table 3**.

All the interviews were audiotaped and transcribed verbatim. The FGs were conducted in Arabic and transcribed and translated. Although translation from Arabic to English could lead to data loss, the researcher's bilingual fluency was crucial for ensuring the collected data were as accurate and consistent as possible. Providing capable, skilled researchers with cross-language qualitative research expertise is a common strategy for translating data (Mohamad et al., 2021).

Participants' confidentiality was protected by assigning pseudonyms. The transcripts were stored on a personal device with the participants' permission to help maintain their anonymity. To validate the data,

participants were given access to the interview transcripts. They reviewed these to verify their responses were accurate. Once confirmed, participant approval of the final transcripts was secured.

Regarding the development of the coding framework, the categories were derived from analytical categories based on prior relevant literature and studies that highlighted teacher adaptation of AI outputs and pedagogical scaffolding in AI-supported learning environments (Bora & Kölemen, 2025; Vorobyeva et al., 2025). Several of these categories were used and cited in earlier studies on AI-integrated lesson design and PST training. This underscores the importance of reflective practice and improved instructional planning in teacher education and the use of AI (Abualrob, 2025; Jantakoon et al., 2025; Taani et al., 2025). Broader research on PST preparation and technology integration, including STEM-based lesson design, also influenced the development of these codes and categories (Alrwaished, 2024). Collectively, these studies provided deductive foundations for the initial codebook in this research. As a result, the final set of themes combines literature-informed concepts with data-driven insights to balance discovery and pedagogical theory in qualitative educational technology research (Celik et al., 2022; Hatch, 2023).

Thematic analysis was conducted using a structured coding process in NVivo. First, transcripts were read multiple times to familiarize them with the data. Initial open codes were then developed line by line, capturing recurring words, ideas, and patterns in participants' responses. Next, related codes were grouped into broader categories. These categories were then continuously refined into themes and subthemes through constant comparison across the FGs. For example, initial codes such as "timesaving," "quick responses," and "less workload" were clustered under the broader theme of the benefits of AI tools. To improve trustworthiness, two researchers independently coded a subset of transcripts and compared results to reach consensus, resolving discrepancies through discussion. This process ensured that the coding framework was transparent, reproducible, and based on participants' perspectives. Subsequently, responses were entered into NVivo, and nodes were used to efficiently analyze and interpret the data. Based on the literature, the data were organized into themes and subthemes. The transcripts were labeled, and codes were generated based on similarities, differences, challenges, and opinions. Additionally, the university's ethical review committee approved this study.

RESULTS

Theme 1. Positive Attitudes Toward Artificial Intelligence-Generated Tools

The data revealed a range of experiences and attitudes toward using AI-generated lesson plans, as well as how they were utilized to create valid lesson plans. Several themes emerge from the data.

Precise prompts

The PSTs generally expressed positive attitudes toward using these tools and highlighted that precise prompts are essential to enhance the results and ensure the accuracy of the lesson plan. The PSTs were optimistic and appreciated how these tools provided quick, well-structured plans using a solid foundation that could be modified to suit their learning environment and context. One PST stated,

> "It was easy to use, even though I thought it was hard. But I have to be very specific about the lesson I want to write" (FG B, student [ST] 17).

This theme recurred for several students. They noted that the accuracy and relevance of these lesson plans directly correlated with how well PSTs formulated their prompts.

Another PST stated,

> "I have found that the more I explain my lesson, the better the lesson plan is" (FG C, ST 24).

These interactions demonstrate how PSTs quickly grasped the importance of clear prompting when working with AI tools. Instead of viewing the tools as automatic generators, participants understood that the quality of the outputs depended on their own clarity and instructional intent. This reflects a growing metacognitive awareness, in line with research highlighting the role of teacher input in guiding AI effectiveness (Zhai et al., 2021; Zhang et al., 2023). These perceptions form the foundation for understanding how PSTs perceive the overall usability of AI tools, which is discussed in the next section.

Using artificial intelligence is a learning curve, but easy to use

Although most students favored using AI tools for lesson plans, they stressed that the training course was a learning curve. Several PSTs recognized that it took various attempts and trial and error to communicate with the tool properly and create *the perfect lesson*. The lesson plan was imperfect and needed to be tweaked and optimized by the participants to be considered complete or sufficient. Most asserted that once they got the hang of using the tool, it became easy to use with adjustments to the lesson. One student emphasized,

> "It took me a few times before I got the hang of it, but it was super easy once I gave it all I had, such as the page from the textbook curriculum and my instruction" (FG B, ST18).

Another student commented,

> "At first, this tool was hard, but after a few tries, I got the hang of it!" (FG B, ST 13).

Theme 2. Advantages of Artificial Intelligence-Generated Tools

The PSTs identified several benefits of using AI tools to create effective lesson plans. These advantages include saving time, providing structures, and increasing the productivity of novices and PSTs. The results highlight how these AI tools support teacher preparation and provide a solid foundation for teachers to adapt their approaches to their specific needs.

Time-saving tool

Participants stated that a key advantage was the considerable time-saving capabilities of AI-generated lesson-planning tools. The ability to rapidly generate comprehensive lesson plans enables PSTs to allocate more time to fundamental teaching tasks, such as classroom management, classroom activities, and student engagement. The PSTs were impressed by the quick responses and the accuracy of some of the ideas generated.

Here are some examples of this theme,

> "This tool reduced the time I would need to plan for the lesson. It gives me more time to do other things like student activities and worksheets … Easier and faster …" (FG C, ST 21).

Another PST shared,

> "The AI saved me so much time; it took me half the time to write it with AI than alone" (FG E, ST 43).

The consistent comments about timesaving indicate that efficiency was a key benefit of AI for lesson planning. PSTs emphasized that by decreasing the workload of drafting lesson plans, they could concentrate on higher-level teaching tasks, such as designing activities and engaging students. This suggests that AI tools can conserve resources for pedagogical decisions, supporting earlier research on the productivity benefits of AIEd (Tapalova & Zhiyenbayeva, 2022). Additionally, participants mentioned that AI helped them in other ways during lesson planning, such as boosting their confidence and inspiring innovative ideas. They also emphasized that creating effective initial lesson plans took time and effort. The AI tool was essential in reducing preparation time by half for a detailed, full mathematical lesson, which is often complicated.

Support for novice teachers

A significant finding was that the AI tools were valued in the training toolkit and provided vital support. This helped them to become efficient planners and motivated them to become more confident as novice teachers. AI tools provide the support required to build confidence in teaching and develop planning skills. One PST shared,

> "As someone who is still very new to teaching, I believe these tools (AI) have been a great support" (FG C, ST 29).

Another PST commented,

> "We have only just learned how to create lesson plans, and being new to this, AI was amazing in guiding me about certain aspects" (FG D, ST 40).

Aligning lesson plans with curriculum objectives

Although AI is imperfect, it can create a range of activities that meet students' needs and levels. The PSTs were optimistic about how the AI would produce outputs that could be tailored to their needs. They found that AI tools are flexible and allow easy modifications, whereas others felt the need for more advanced customization options. One student added,

> "I like how it gives me ideas, but I can change them to suit my students' needs" (FG E, ST 41).

Another responder suggested that

> "AI is great, but if we can guide it in the right manner, it is easy to change the way the lesson structure is, modify what I like, and delete what I do not feel is necessary" (FG D, ST 39).

The ideas generated during the training did not originate from the participants themselves, but rather from the AI tools, which offered suggestions by drawing on multiple online datasets and repositories. PSTs saw these AI-generated ideas as new and used them as a foundation to adjust and personalize their own lesson plans. The participants felt that the AI provided them with more ideas than they would have come up with on their own. This generated ideas that sparked interest and gave students something to work with. One participant noted,

> "AI gave me ideas and great activities! I would not have considered them. My objectives needed to be tweaked, but overall, it was clear" (FG B, ST 20).

Theme 3. Challenges of Using Artificial Intelligence Tools

While the PSTs recognized the many advantages of using AI, the results highlighted four main challenges in using these tools for lesson planning. While the PSTs valued the advantages of using AI tools, they also documented that their effectiveness relied on their capacity to navigate their limitations and tailor their outputs to meet classroom objectives and students' needs. The main challenges observed were an overreliance on AI tools, inaccuracy issues with images and information, ethical considerations, training, and technological skills. **Table 4** summarizes the main challenges observed.

Table 4. Challenges of using AI tool for generating lesson plans

Theme	Justification	Quote extractions	Keywords
a. Overreliance on AI tools	A big concern was that using AI may lead to a reduction in creativity. Some also dread that using AI often might make them dependent on using AI tools instead of their own skills.	*"I'm worried if I overuse these tools, I will become lazy and reliant on them."* & *"AI makes me not want to think, just input information and watch it work!"*	Overuse, overreliance, & skills
b. Inaccuracy–Images and information	Some images, equations, and diagrams did not appear using the software. Additionally, some images were not recognized by the tool, such as the number line. The AI tool was not able to produce it.	*"I kept asking the tool to provide an image of different angles and triangles; however, it kept on saying it could not, or it provided me with a wrong image."* & *"The AI-generated lesson plans need to be checked thoroughly; they also need to make sure that the curriculum aligns with the plans."*	Modify, missing inaccurate, images, missing, equations, & relevant information
c. Ethical considerations	Ethical concerns were also raised about how to use the generated lesson plan.	*"I don't want to just copy-paste the information from the tool."* & *"It is hard to use the information without either stating that AI was used and I also need to customize it, so it is my own"*	Ethically use, copy, & plagiarism
d. Training and technology skills	Although AI tools are relatively easy to use, some participants found it difficult and appreciated the training that was given by the researchers.	*"I need clear instructions and practice before I use these tools."* & *"If we did not get training on this tool, it would have been difficult for me to use on my own."*	Training, tech skills, assistance, & difficult

DISCUSSION

This research explored the attitudes and perspectives of PSTs toward using AI for lesson planning. AI tools are generally well received for their ease of use and time-saving benefits, but challenges with integration and potential improvements have also been identified.

Positive Attitudes

PSTs' positive responses to AI-generated lesson plans mainly stemmed from their ease of use. The interface is intuitive, and PSTs need minimal technical skills to become proficient tool users, meaning PSTs who can combine AI-produced outputs with their own pedagogical knowledge, modify materials to suit the classroom context, and apply professional judgment in lesson planning. This was especially helpful for novice PSTs, who might find lesson planning intimidating due to their limited experience or lack of practice. Generative AI tools offered significant support, allowing these teachers, who were either hesitant to use technology or still building confidence, to focus more on content, activities, and classroom delivery rather than the technical details of lesson planning. AI tools aided teachers who were reluctant or had minimal prior experience with technology in shifting their attention to content, activities, and lesson delivery. For instance, Alyana AI generated scaffolded problem-solving questions and sample discussion prompts, which reduced the time spent creating materials. Similarly, MagicSchool offered ready-to-use worksheet structures that teachers could modify. This may give them the confidence to focus on facilitating learning instead of struggling with resource creation. These findings align with existing research highlighting the potential benefits of using AI generative tools to help PSTs create effective lesson plans (Ayanwale et al., 2024; Celik et al., 2022; Goodman et al., 2024; Shah, 2024).

Timesaving has been documented as a benefit that allows educators to focus on other tasks. For example, Zhai et al. (2021) discussed how AI can help educators save time, which supports the results of this study that emphasize the time-saving advantages of using AI tools in education. Additionally, our research suggests that AI tools can be effectively integrated into the existing curriculum, offering innovative activities and personalized teaching methods. This aligns with Tapalova and Zhiyenbayeva (2022), who argue that AI tools offer several benefits in educational settings, including the *generation of relevant and practical learning content* and the provision of effective teaching methods tailored to learning contexts and knowledge levels (p. 647).

Artificial Intelligence Training

Additionally, the fast-paced learning curve reported by the PSTs further underscores the value of using AI generative tools in teaching practices. Our findings suggest that when tools are easy to use and PSTs understand their functionality, they become more enjoyable and efficient. These findings are consistent with a study on AI and PSTs' acceptance of using AI by Zhang et al. (2023), which found that PSTs who believed that AI tools were enjoyable were inclined to be more motivated to learn about and use AI and will, in turn, increase their probability of integration and perceive the system as being easy to use. The PSTs consistently stressed how quickly they could create lesson plans, freeing up valuable time for other essential teaching properties, such as assignments, activities, and classroom management. Once the PSTs are familiar with the basic functionalities, they can leverage them to create coherent, well-structured lesson plans. This resulted in an easier, more functional method for creating lesson plans, making the process more efficient and manageable. Therefore, this research emphasizes the importance of teacher training with these tools. Tapalova and Zhiyenbayeva (2022) argued for the importance of AI training for teachers and students to ensure a personalized, practical learning experience.

Productivity and Support for Preservice Teachers

Structured lesson plans generated by AI offer a clear and logical framework for PSTs. This gave them the confidence to learn how to plan lessons and generate innovative ideas. These findings suggest that AI tools support PSTs and novice teachers, aid in critical thinking and planning skills, and generate new ideas for lesson preparation. These findings align with prior studies (Pender et al., 2022; Setyawan et al., 2024). Setyawan et al. (2024) investigated the use of AI to create Arabic lesson plans. They found that using AI-enhanced tools

supported participants' learning satisfaction, motivation to use AI, and learning outcomes, which aligns with our current study.

Artificial Intelligence Tools' Ability to Draw from Diverse Curricula

This study highlights AI's ability to draw from various online sources and provide more accurate lesson plans. AI is considered adaptive and capable of learning and improving its performance based on the information, experience, and feedback provided. This finding is consistent with the findings of several previous studies. Wang et al. (2024) reviewed 125 articles on the application of AI in educational settings. They found that AI is considered a hub for data mining and learning analytics, which help provide profiling and predictive capabilities for education. They suggested that AI could predict and select the best possible outcomes for curriculum planning and *teaching optimization.* This is a dynamic feature, particularly in teacher training and lesson planning. The content provided by AI is based on data from multicultural and diverse educational environments, which can be an asset for student lesson plans, enriching them with different ideas, teaching strategies, and content. For instance, the PSTs noted that AI presented creative activities or objectives suited to their teaching contexts. This access to a broader range of resources helped expand PSTs' repertoire of teaching strategies and enabled them to adapt their lessons to suit their teaching environments better.

Challenges and Solutions

Despite AI's ability to pool from different curricula, it also presented several challenges, as some PSTs mentioned that the generated lesson plans required customization to meet specific curriculum standards, necessitating precise input on objectives, resources, tools, and assessments. These findings align with those of Van den Berg and du Plessis (2023), who found that although AI provided a comprehensive, structured lesson plan, it requires substantial modification to refine objectives, modify specific content, and address issues such as plagiarism and ethical considerations.

Another challenge is the steep learning curve required to effectively use AI tools. While the AI tools are easy to use, crafting precise prompts is important. Moreover, maximizing AI capabilities requires time, practice, and patience. Additionally, PSTs observed technical issues using mathematical equations and images. This could be due to the tool's complex nature and the need for sufficiently specific prompts. Images and graphs are challenging to produce using AI, which may be a drawback of AI that can be rectified by having teachers customize and address these drawbacks with either images from the Internet or personal graphs. This finding suggests that AI can enhance efficacy, but it requires specific technical skills and familiarity to use it effectively, while also allowing for modification and addition as necessary. This is consistent with studies on AI in various education settings (Jòrayeva & Akmalxonov, 2024; Kehoe, 2023).

Some AI-generated content is not aligned with or relevant to the current context, making it misleading or unclear. This is not an AI limitation, as AI generates content based on previous information, external websites, and user feedback (Wang et al., 2024). Consequently, PSTs must invest additional time and effort in adapting AI-generated plans, as they are best positioned to understand their context, not the AI. This finding suggests that although AI tools are valuable resources, they are not yet sufficiently complex to replace the teacher's essential role in providing input to meet specific needs. AI is a tool that helps teachers but does not replace them. Lee and Zhai (2024) agreed with this statement and found that participants were concerned about the accuracy of AI generative tools and believed they needed improvement.

Furthermore, the results suggest that AI raises ethical considerations and poses potential risks. The PSTs recognized that these risks were an inherent part of AI use. Therefore, PSTs, educators, and institutions must carefully navigate the ethical use of AI to avoid bias. This is consistent with the current literature (Ayanwale et al., 2024; Jòrayeva & Akmalxonov, 2024; Okagbue et al., 2023). Shah (2023) and Van den Berg and du Plessis (2023) support this finding, arguing that transparency is necessary when using AI. They stress the importance of critically evaluating generative AI content before being used to avoid privacy concerns, bias, and ethical issues. Moreover, there are concerns about the potential for overreliance on AI-generated tools, which could lead to a decline in teachers' critical thinking and creative skills in developing lesson plans. This finding aligns with other studies that emphasize the importance of balanced integration (Goodman et al., 2024; Lee & Zhai, 2024).

Implications and Recommendations

This study has several implications for future research. The ability of AI to utilize and leverage diverse resources has significant implications for integrating AI tools into teacher training programs and professional development. PSTs should be immersed in and develop technical skills to evaluate, use, and adapt AI-generated content to ensure standard curriculum alignment. As innovative tools continue to emerge in the market, teacher-training programs and higher education institutions should integrate more comprehensive modules into their programs, including the development of prompt-crafting skills, critical thinking skills, and proper steps for utilizing AIEd. They should also constantly stay up to date with current trends in innovative education. Preparing and empowering PSTs to use AI will help minimize the identified challenges and maximize the benefits of these tools, enabling them to produce high-quality, tailored lesson plans (Jòrayeva & Akmalxonov, 2024). These findings may pave the way for educational institutions to incorporate innovative tools into their standard educational practices as a central part of their offerings. This may include forming partnerships with developers or using AI tools on existing educational platforms, enabling both novices and experienced teachers to access the resources needed to plan practical lessons.

Ultimately, the insights gained from this research have implications for educational policy and practice, particularly regarding the incorporation of AI tools into school curricula and teacher development programs. The results suggest that providing university administration and policymakers with an official ethical and academic guide for teacher-training programs on when and how to use these technologies responsibly would be beneficial. With the influx of AI research, Escotet (2023) has provided clear guidelines for educators in higher education, administrators, and policymakers regarding the use of AI. Escotet (2023) believes that AI has the potential to revolutionize education by offering personalized learning experiences and emphasizes the importance of addressing ethical responsibilities in its use. In other words, AI may analyze performance data and provide or recommend specific strategies, teaching objectives, and resources that align with the subject matter based on the data imported into the systems (Celik et al., 2024; Luan & Tsai, 2021). Policymakers also have the responsibility to encourage students to embrace technology as a learning aid to enhance the learning experience. These principles and policies must be in harmony with learners' goals and ethical values. Educators and universities play a particularly crucial role in higher education (Alreiahi et al., 2024). Additionally, a robust policy must be implemented in any higher education program to integrate AI into educational settings. In alignment with these findings, Evangelista (2025) provided a comprehensive framework for training students and educators to ensure integrity and fairness when using these tools, which includes implementing ethical governance guidelines, utilizing AI detection tools, designing assessments, providing student and educator training, and monitoring and reinforcing best practices (p. 12).

Limitations

While this study's findings provide valuable insights into PSTs' perspectives on using AI tools for lesson planning, several limitations must be acknowledged. One limitation is the small sample size, which may have limited the generalizability of the findings. The participants in this study were predominantly from a specific geographic region and shared similar educational and cultural backgrounds, which may be generalized only in these contexts. However, we argue that this training framework can be applied in any context and subject area, regardless of the region, if it has access to these AI tools. Another limitation is that the research focused on the specific AI tools available during the study.

Future Research and Gaps

This study offers valuable insights into the use of AI in lesson planning. However, it also points out several important gaps that future research should explore. There is a clear need for broader, more detailed studies that examine how AI-generated lesson plans affect teaching strategies, student engagement, and learning outcomes across different educational settings and contexts. Additionally, future research should investigate the long-term effects of AI-supported lesson design on PSTs' creativity, critical thinking, and decision-making. This is crucial because concerns about over-reliance on AI still need further investigation. Excessive reliance on generative tools may unintentionally obstruct these vital skills, raising concerns about deskilling or overreliance on automated outputs. More research is necessary to understand how teacher-training programs can balance AI use with creativity and professional judgment. Lastly, since this study was conducted

in the Middle East, applying the same training framework across diverse cultural and educational settings would help assess its generalizability and adaptability.

CONCLUSIONS

The findings of this study reveal both the potential and limitations of using AI tools in PST education. AI-supported lesson planning tools clearly offer time-saving benefits and practical scaffolding for novice teachers, helping them design and structure lessons more efficiently. However, challenges related to accuracy, ethics, and overreliance also arise. While AI provides valuable support, effective teaching still depends on pedagogical reasoning, creativity, and professional autonomy. The PSTs in this study mainly used AI as a brainstorming tool to modify, refine, and contextualize content rather than relying on it entirely. These results suggest that AI can facilitate teacher development when used within pedagogically rich, critically reflective environments and scaffolding opportunities. As AI generative tools develop, ongoing research will be essential to harness their potential to improve educational practices and teacher training while protecting the integrity, critical thinking skills, and creativity of future teachers.

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Data availability: Data generated or analyzed during this study are available from the corresponding author upon reasonable request.

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APPENDIX A: SAMPLE INTERVIEW QUESTIONS

1. How have AI tools helped you to create lesson plans for your math curriculum?
2. What skillsets did you acquire when using AI-enhanced tools in your lesson plan?
3. Please describe your experience using AI to generate your lesson plans.
4. What challenges did you encounter when using these tools, and why?
5. What are the benefits of using AI in lesson planning that you see as a preservice teacher?
6. How can you ensure you ethically use AI when creating lesson plans?
7. Please provide feedback on using AI in lesson planning.
8. What skillsets did you acquire by incorporating AI-enhanced tools into your lesson plan?
9. How has using AI tools changed your lesson-planning skills?

