Pre-Service Teachers' Dual Perspectives on Generative AI: Benefits, Challenges, and Integration into their Teaching and Learning

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Abstract

This study examined pre-service teachers' perspectives on integrating generative AI (GenAI) tools into their own learning and teaching practices. Discussion posts from asynchronous online courses on ChatGPT were analyzed using the Diffusion of Innovations framework to explore awareness, willingness to apply ChatGPT to instruction, and potential benefits, challenges, and concerns about using GenAI in teaching and learning. The course discussions significantly increased pre-service teachers' awareness and foundational knowledge while reducing anxiety towards AI technologies. However, despite exposure to ChatGPT, only a few confirmed intentions to adopt AI tools in their teaching practices, potentially reflecting lingering uncertainties evidenced by emotional responses, such as worry and concern. Professional development in AI literacy can address these uncertainties and enhance teachers' understanding about using GenAI in class. The study offers insights into responsible GenAI adoption in education and how higher education can leverage ChatGPT to enhance pre-service teacher learning.

Keywords: GenAI, ChatGPT, online asynchronous course, instructional design, pre-service teachers

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As the development of artificial intelligence (AI) technologies for education continues to grow at a rapid pace (Prahani et al., 2022), teachers play a pivotal role in the conversation about how AI tools should be designed and implemented to support learning and teaching (Seufert et al., 2021). The recent launch of the Generative Pretrained Transformer in 2022 (e.g., ChatGPT) has triggered global interest in AI, particularly in using generative AI (GenAI) for teaching and learning in classrooms. Due to its easy, fast, and efficient ability to generate human-like text in response to the input it receives, ChatGPT has become one of the first GenAI technologies accessible to the public. For example, ChatGPT can perform various tasks, such as answering questions, writing essays, summarizing documents, and generating images. Initially, when GenAI tools were first introduced, educators raised concerns about potential issues, such as enabling plagiarism as well as perpetuating biases and circulating misinformation (Na et al., 2024). However, it was recently observed that instead of outright banning these AI tools, school districts began developing AI policy for schools and offering professional development programs to help in-service teachers better understand and use these tools (e.g., New York City banned the ChatGPT in 2022, but they lifted the ban in 2023).

This trend indicates a growing recognition of the importance of early exposure to AI concepts and tools for young students. This exposure helps build students' core competencies and workplace skills for their future careers, preparing them to adapt to AI-based environments across various fields (Huang, 2021; Kong et al., 2022; Touretzky et al., 2019; Yang, 2022). For instance, AI is already being used in numerous areas from diagnosing diseases to recommending advertisements. In addition, educators have raised equity concerns, noting that limiting students' opportunities to learn how to use AI tools at school and their lack of access to these tools can contribute to educational equity issues (Roscoe et al., 2022; Swindell et al., 2024). Despite the significance of teaching and learning AI concepts in school settings, teachers often face challenges in this area. One of the primary difficulties stems from their limited content knowledge related to AI concepts (Kim & Kwon, 2023; Su et al., 2022), as well as limited prior experience with AI tools. This can lead to teachers feeling unprepared and lacking the necessary competencies to implement AI tools effectively in classrooms, which in turn may result in self-doubt and reluctance to implement AI tools (Kim & Kwon, 2023).

Therefore, it is crucial to understand teachers' perspectives on incorporating AI tools in their classrooms to aid their successful adoption. Beyond technical proficiency, teachers must also cultivate pedagogical competencies to effectively integrate GenAI tools into their instructional practices. Recent research underscores the importance of incorporating strategies that illustrate how GenAI can enhance teaching, promoting critical thinking and creativity to equip students with the skills needed to navigate the complex digital environment infused with AI technologies (ElSayary, 2023; Okulu & Muslu, 2024; Uzumcu & Acilmis, 2023). In this study, we examined pre-service teachers' perspectives on utilizing ChatGPT for their learning and teaching. The term *pre-service teacher* is used to describe a student enrolled in a teacher preparation program, who must complete coursework and field experience before earning a teaching license. They engage in academic study, gain supervised teaching experience, and often work with a mentor to prepare for their future careers in education. Pre-service teachers are unique in that they are simultaneously considering their own learning while preparing to teach, which can significantly influence their approach to teaching their future students (Borg, 2006;

Farrell, 1999). Research studies emphasized the importance of pre-service teacher beliefs/pre-conceptions, as it is widely acknowledged that pre-service teachers enter teacher training programs with firmly established ideas about learning and teaching that are developed during their prior experiences as students (Pajares, 1992). These initial ideas can act as filters, shaping how pre-service teachers perceive and interpret new information/tools they encounter. In other words, the pre-service teacher preparation effort is crucial in facilitating transformative learning experiences, wherein pre-service teachers assume dual roles/positions—not merely as passive recipients of knowledge but as active participants in dialogue who critically and practically engage with the technological and ethical aspects of tools for their learning (i.e., as an undergraduate student) as well as teaching (i.e., as a pre-service teacher). Thus, the goal of this study was to explore pre-service teachers' perceptions of GenAI in an online learning environment, focusing on their willingness to integrate it into their instruction, as well as the potential benefits, challenges, and ethical considerations of using GenAI in teaching and learning. Guided by the framework of the Diffusion of Innovations model, the following research questions were addressed in this study:

1. Through what stages do pre-service teachers progress in adopting GenAI tools, and how do they envision integrating them into their teaching practices?

2. What are the perceived advantages and challenges pre-service teachers anticipate when utilizing GenAI in educational contexts?

Teacher Preparation for Artificial Intelligence (AI) in K-12 Education

AI has reshaped education, opening a new pathway to personalized learning, efficient assessment, and enriched insights into student learning engagement (Markauskaite et al., 2022). While the sub-concepts of AI—including machine learning, natural language processing, and computer vision—remain crucial foundations in understanding AI, recent research has broadened their scope to encompass AI literacy from a critical perspective. Ng et al. (2021) suggest that AI literacy should extend beyond technical skills to include engagement with AI's ethical, social, and cultural dimensions. This literacy enables educators to use AI tools responsively in educational settings, thereby enhancing learning outcomes. This advancement highlights the essential role of equipping educators with a deep and critical understanding of AI's applications and implications. Bozkurt and Bae (2024), in a similar vein, emphasized to educators the need for a critical and balanced perspective on the effectiveness of AI. Sperling et al. (2024) underscore the necessity for AI literacy in teacher education, advocating for curricula that empower educators to effectively harness AI technologies. Similarly, Casal-Otero et al. (2023) advocate for embedding AI literacy into K-12 education, emphasizing the importance of preparing teachers with the foundational concepts of AI and its educational applications.

Recent studies (Chounta et al., 2022; Lindner & Berges, 2020; Salhab, 2024) reveal a mixed reaction among educators toward AI in education, acknowledging its potential to support

personalized learning but also expressing concerns about ethical issues and the need for further professional development. These studies highlight the gap in educators' understanding of both AI technology and its application in pedagogy. However, pre-service teachers, who are still in the process of forming their teaching philosophies and practices, may exhibit different attitudes and behaviors toward technology compared to their in-service counterparts. Pre-service teachers are often more open to adopting new technologies and pedagogical approaches (Tondeur et al., 2012), as they have not yet established deeply rooted teaching practices. Moreover, pre-service teachers' dual roles as learners and prospective educators uniquely position them to critically engage with AI tools and their implications for both their own learning and their future students' learning experiences.

A group of studies on ChatGPT in education (ElSayary, 2023; Lin et al., 2024; Okulu & Muslu, 2024) demonstrate their positive impact on creativity, understanding, and engagement, emphasizing the advantages of integrating GenAI into educational processes. This aligns with prior research (Lemon & Garvis, 2016; Luik et al., 2018; Wang, 2002) that explored educators' views on technology in education, noting the evolving role of the teacher in technology-enhanced classrooms and the importance of confidence in digital tool use. Pre-service teachers' exposure to GenAI tools during their teacher preparation programs can help promote their readiness and willingness to integrate these technologies into their future classrooms (Tondeur et al., 2012). However, it is necessary to consider the potential drawbacks of using ChatGPT in education. Fui-Hoon Nah et al. (2023) explain that the overreliance on AI-generated responses may lead to a decrease in critical thinking and problem-solving skills among students. Also, concerns about cheating and the erosion of academic integrity have been raised (Yeo, 2023). As pre-service teachers plan to integrate GenAI tools in their future classrooms, it is crucial for them to be aware of both the potential benefits and challenges and to develop strategies to mitigate the risks while harnessing the advantages of these technologies.

To address these concerns and maximize the benefits of GenAI in education, pre-service teachers should engage in discussions on the societal implications of GenAI, incorporating ethical reasoning and creative AI applications into the curriculum (Casal-Otero et al., 2023; Sperling et al., 2024). This approach ensures future educators gain technical proficiency and the ability to critically assess AI's broader impact on their teaching and guide their students accordingly. Pre-service teachers are pivotal in this transformative learning journey, crafting AI-empowered curricula that encourage critical thinking, creativity (Uzumcu & Acilmis, 2023), and ethical reflection. Introducing accessible AI tools, such as ChatGPT, showcases innovative learning experience examples generative AI can provide, fostering engagement and exploration across subjects. Such integration during pre-service teacher education is crucial for preparing future educators to navigate the complex digital environment, equipping them with the skills for critical and ethical interaction with AI technologies (ElSayary, 2023; Okulu & Muslu, 2024). Cultivating a thorough understanding of AI's capabilities and challenges enables pre-service teachers to prepare students and their future students for digital learning opportunities and obstacles.

Impact of Anxiety and Uncertainty of AI on Teachers

When thinking about AI and its educational implications, it is important to reflect upon what society thinks about the technology as social perception shapes the teaching and learning of

the technology. The rapid advancement of AI has caused varying opinions about the technology. While it is inevitable that AI potentially has significant benefits for human society (Yang et al., 2021), the uncertain aspect of AI is causing anxiety among people (Johnson & Verdicchio, 2016). In fact, public figures in the technology sector, such as Bill Gates and Elon Musk, have been raising concerns about AI potentially bringing catastrophic repercussions in the future when not utilized properly (Johnson & Verdicchio, 2016; Wang et al., 2022). Such worry mainly stems from the fear of losing control over AI due to its autonomous nature, and this sense of losing control is the main difference between AI anxiety and formerly prevalent computer anxiety (Wang et al., 2022).

Although the aforementioned issue of control can be considered one of the main factors of AI anxiety, there may be several dimensions of anxiety in play. By integrating fear acquisition theory by Rachman (1977) and Menzies and Clark (1995), Li and Huang (2020) organized eight anxiety factors: privacy violation anxiety, bias behavior anxiety, job replacement anxiety, learning anxiety, existential risk anxiety, ethics violation anxiety, artificial consciousness anxiety, and lack of transparency anxiety (p. 3). In a similar vein, Wang and Wang (2019) divide AI anxiety into four dimensions: learning, AI configuration, job replacement, and sociotechnical blindness (p. 624). Such categorization illustrates the multifaceted nature of AI anxiety. Oftentimes, AI anxiety negatively affects people's attitudes toward AI. Wang et al. (2022) found that learning anxiety and job replacement anxiety can negatively impact students' motivation to learn AI, and Kaya et al. (2024) found that AI learning anxiety and AI configuration anxiety negatively impact people's attitudes toward AI. This demonstrates that AI anxiety can be a roadblock for students and teachers alike in successfully teaching and learning AI concepts in schools despite its growing importance.

Moreover, due to technological advancement in schools, expectations toward teachers to be successful in internalizing and implementing new technologies exist, and this can also potentially cause anxiety (Henderson & Corry, 2021). Therefore, it is important to understand how teachers are coping with the AI integration in school settings, what types of AI anxiety exist among pre-service teachers who will be utilizing AI in schools, and how teachers can cope with it (Ayanwale et al., 2022; Hopcan et al., 2023).

Theoretical Framework: Diffusion of Innovation Theory

Diffusion of Innovations (DoI) is a well-established social theory that describes how innovations are adopted across different populations (Rogers, 2003). This framework is applicable to the investigation of the process of innovation adoption, particularly in the field of educational technology (Jwaifell & Gasaymeh, 2013). We used the term "innovation" to refer to any novel instructional strategy, tool, or learning resource that an instructor could employ to enhance student learning and engagement. This definition thus includes both educational practices and tools. Diffusion entails the acceptance or rejection of innovation by individuals and groups. Rogers (2003) characterizes the process of diffusion of innovations as "an information-seeking and information-processing activity," where individuals make sense of information about an innovation to decide whether they will adopt or reject it (Lund et al., 2020). Recent applications of DoI theory include studies on e-book adoption among university students (Qazi et al., 2018), such as the adoption of online proctored examinations during the COVID pandemic (Raman et al., 2021) and the adoption rate of AI applications in online learning environments

(Almaiah et al., 2022). It is important to note that while several theoretical frameworks discuss innovation adoption, they primarily conceptualize the factors influencing the utilization or acceptance of the innovation. In contrast, this study specifically focuses on the comprehensive process of innovation adoption. Using the DoI framework can afford researchers to identify the stages of students' experiences and proactively address their needs. This approach allows for targeted instructions at each adoption stage, from raising awareness to promoting sustained use. By tracking and analyzing adoption cycles, instructors can refine learning activities and materials to maintain student engagement and support meaningful adoption. In particular, we address challenges encountered during the implementation that led to the adoption process, aiming to fill a gap in the implementation stage.

Based on the DoI theory, we categorized the decision process for AI adoption, consisting of the following six stages (see Table 1). First, the Awareness/Knowledge Stage involves becoming aware of the innovation and gaining cognitive knowledge. This stage is related to being exposed to the innovation and seeking information about how to use it. In the Interest Stage, learners form opinions about the innovation while addressing knowledge gaps and uncertainties. They may be influenced by social encouragement to use the innovative tool, as well as by peer-group members' favorable subjective reviews of the tool. Otherwise, learners may have a negative attitude toward adopting AI due to the influence of social discourses on the ethical issues of using AI. The Decision Stage involves individuals deliberating whether to adopt or reject the innovation, influenced by factors like personal interest, social pressure, or policy requirements (Frei-Landau et al., 2022). After deciding to adopt, individuals test and evaluate the innovation in the Trial Stage, adapting it based on feedback and their specific needs. Making more adaptations for their own purposes might increase the chance for individuals to use them more consistently. In the Confirmation Stage, the users establish a strong judgment for their decision on the innovation adoption as they reflect on their experiences and its outcomes. In this stage, the users demonstrate more concrete use cases of the tool in their specific context. For the last stage, we added an Advocacy Stage, which entails garnering public support or recommendation for the tool. In today's digital-centered society, where information is readily accessible and widely shared online, it is crucial to showcase hands-on examples of how innovative tools are being successfully adopted and utilized. By sharing use cases online and advocating for these tools in public forums, such as through social media, blog posts, webinars, or presentations, individuals and organizations can highlight the tangible benefits and effectiveness of the tools. This not only helps to build awareness and generate interest but also establishes credibility and trust in the technology. Additionally, it provides valuable insights and inspiration for others who may be considering adopting similar tools, ultimately fostering a community of learning and innovation.

Table 1

Diffusion of Innovations Theory Framework

Stage	Definition	Example

Awareness/ Knowledge	Awareness of innovation and relevant cognitive knowledge	*After researching, I learned ChatGPT's responses are derived from web sources.*
Interest	Perspective and attitude regarding innovation	*I see an opportunity for individualized and personalized teaching and learning.*
Decision	Tentative plan or intention to adopt or reject innovation tools for future use	*I think that in the future as an educator I will have to look out for this to ensure that my students are getting a proper education and not taking the easy way out.*
Trial	Utilization of innovation tools and exploration of its results	*When I go back and use ChatGPT, I have had no issues but am always pleasantly surprised by the information provided.*
Confirmation (Adoption/rejection)	Explicit judgment on the adoption of innovation tools after trials	*Overall, I have thoroughly enjoyed utilizing this program as it has proven exceptionally beneficial in developing engaging lessons for two-year-old children.*
Advocacy	Endorsement of adopting innovation tools to the public	*So far, though, I like what I'm seeing and might even suggest this software be used where I work.*

Methods

Research Participants and Data Sources

The study involved 54 pre-service teachers (male = 28, female = 26) from a Southeastern university in the United States, within the age range of 19-30. Each participant enrolled in one of the four-week asynchronous online courses (i.e., Computer Concepts and Application, Computer Education Application, and Computer Education Curriculum Development). The data collection

took place over a period of one month, followed by three months of data preprocessing and analysis. One of the research team members was the instructor for these courses, which focused on introducing generative AI for K-12 education. Before the study, none of the students were familiar with GenAI or ChatGPT, so the instructor provided pre-tutorial on how to use prompting questions/statements when interacting with ChatGPT to yield good results. The tutorial included a 30–40-minute video and supplementary text materials on the interface and user experience of ChatGPT. The courses used ChatGPT as a teaching assistant, augmenting students' brainstorming and writing activities. No incentives or bonus grades were provided to study participants for their involvement. To ensure that there was no undue influence or coercion (even perceived) of students to participate, we conducted several steps. Participation was completely voluntary, and it was emphasized that non-participation would not negatively impact students' grades or standing. Informed consent was handled confidentially. To ensure effective use of ChatGPT during the course, the instructor provided pre-service teachers with a series of ChatGPT tutorial materials before the discussion activities. To enhance students' engagement and participation in discussion, we incorporated a gamified plugin called ClassCred in Microsoft Teams. This plugin allowed us to gamify the learning experience by awarding points and badges based on the quality and frequency of participants' contributions.

Under this discussion platform, the instructor facilitated weekly group discussions to engage in different topics regarding using ChatGPT. For each weekly group discussion, we presented one of the following prompting questions:

(1) Do you have any existing expectations regarding the application of AI in learning tasks? If so, what are these expectations and what preconceptions do you have?

(2) Have there been any issues, challenges, or points of difficulty concerning the content provided by ChatGPT?

(3) What would be an effective strategy to use AI ChatGPT for task completion or problem-solving? What good strategies do you think are available?

(4) Throughout your use of ChatGPT during this course, have you experienced, noticed, or considered any issues or concerns related to ethics in AI use? For example, what are your impressions about the representativeness of AI responses?

In addition, the pre-service teachers participated in an AI anxiety survey before and after the course, which was developed by *Wang and Wang (2022)* and consisted of 57 questions on AI anxiety to triangulate the findings from the discussion postings. The instrument measures AI anxiety related to learning (e.g., Learning to use AI techniques/products makes me anxious), AI configuration (e.g., I find humanoid AI techniques/products (e.g., humanoid robots) scary), job replacement (e.g., I am afraid that an AI technique/product may make us dependent), and sociotechnical blindness (e.g., I am afraid that an AI technique/product may be misused). The survey was administered fully via an online survey form. A total of 26 pre-service teachers responded to this survey with a 7-point Likert Scale (Strongly Agree: 1, Strongly Disagree: 7). Lower scores indicate higher anxiety regarding AI technology and its societal impact.

Data Analysis

Following the anonymization of students' names, our team engaged in a detailed discussion to operationalize the DoI framework, ensuring each state was clearly linked to specific behaviors observed in the data. We redefined each stage of the framework with illustrative examples to clarify its application to our codes. After finalizing the codes among the research team, two researchers conducted a detailed analysis of each sentence in students' discussion posts and their comments. Among 2966 sentences, a total of 2629 were analyzed using six stages of the DoI framework (Rogers, 2003) (i.e., Awareness/Knowledge, Interest, Decision, Trial, Confirmation, and Advocacy.) The rest, which were not directly relevant to the framework, were coded as "Others," such as student questions (e.g., "Who is behind the coding to give AIs these types of intelligence?") and linguistic markers that support peer interactions in the weekly discussion threads, (e.g., "I agree with you"). These reciprocal statements and off-topic utterances (e.g., "I think it can be hard for teachers to meet the needs of every student in their classroom") were coded as "Others."

The analysis process included two phases. First, the researchers randomly sampled 20% of the entire discussion postings from each week of all courses and independently coded them. Then, we discussed the coding results with rationales to resolve any discrepancies and reach an agreement during research meetings. Once the inter-rater agreement for coding results reached 75.4%, two researchers independently coded the remaining data based on the finalized coding scheme. The calculated Cohen's kappa statistics value is .634 (p <.001), indicating substantial inter-rater reliability in the coding results. Then, the researchers employed inductive thematic analysis (Braun & Clarke, 2006) to examine students' discourse on integrating ChatGPT for their learning and teaching. Reading through discussion threads, we noted the emerging themes on pre-service teachers' perceived benefits, ethical and societal concerns, and challenges of using ChatGPT in educational contexts. After a couple of data sessions during the research team meetings, we recategorized and finalized distinctive themes. The specific themes are described in the findings section.

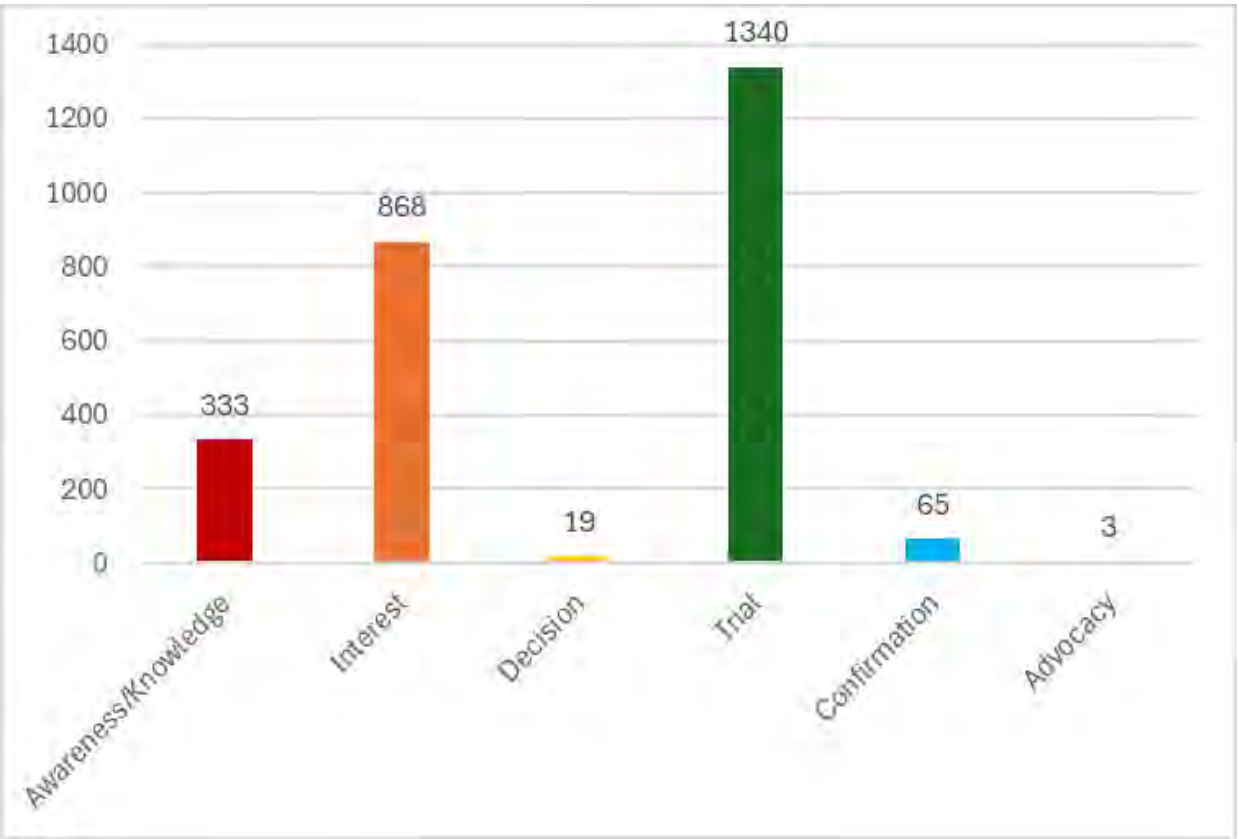
Findings

Different Stages of Pre-service Teachers' Adoption of GenAI Technologies

Throughout discussions on GenAI technologies, pre-service teachers demonstrated different stages of DoI (see Figure 1). Their discussions heavily centered on the Trial stage, where they shared hands-on experiences in using ChatGPT (*n=1340*, 51.0%), followed by the Interest stage, where they addressed their opinions and perspectives (*n=868*, 33.0%). General ideas and superficial level of knowledge were also mentioned (Knowledge/Awareness, *n=333*, 12.7%), and some students stated their decision on whether to use ChatGPT (Decision, *n=19*, 0.7%). Although discourse on user experience on ChatGPT was frequent, they rarely reached the Confirmation (*n=65*, 2.5%) or Advocacy (*n=3*, 0.1%) stages. The result indicates that students became familiar with ChatGPT as they were encouraged to use the AI tool in class, but they showed hesitance or confusion in adopting it for their teaching and learning. For instance, one student stated that they tried to "remain mindful of ethical considerations, avoiding using ChatGPT for promoting biased or harmful content."

Figure 1

Total Number of Coded Sentences for Each Stage



The most dominant stage and its distribution varied from week-to-week, as illustrated in Figure 2. In the first week, students were required to use ChatGPT and share their expectations or preconceptions of the application of GenAI technologies. As they shared their own perspectives and attitudes after using ChatGPT for the first time, the Interest stage appeared the highest (*n=346*, 54.7%). The Trial stage was the next highest (*n=149*, 23.5%) as they explored the ChatGPT tool to participate in online discussions and share their thoughts. However, some remained in the Awareness/Knowledge stage (*n=125*, 19.7%). This observation can be attributed to their recent exposure to these technologies, suggesting that they were still in the process of familiarizing themselves and were not yet expected to engage in discussions beyond their prior knowledge.

In the second week, the pre-service teachers were tasked with exploring issues or challenges associated with using ChatGPT. As a result, a significant number of students transitioned to the Trial stage (n=477, 71.4%), where they actively engaged with the tool to evaluate their experiences related to its performance and identify any potential issues, indicating a shift from their previous activities. In addition, there was an increase in their posts related to the Confirmation stage (n=26, 3.9%) and the Advocacy stage (n=2, 0.3%), showing that some

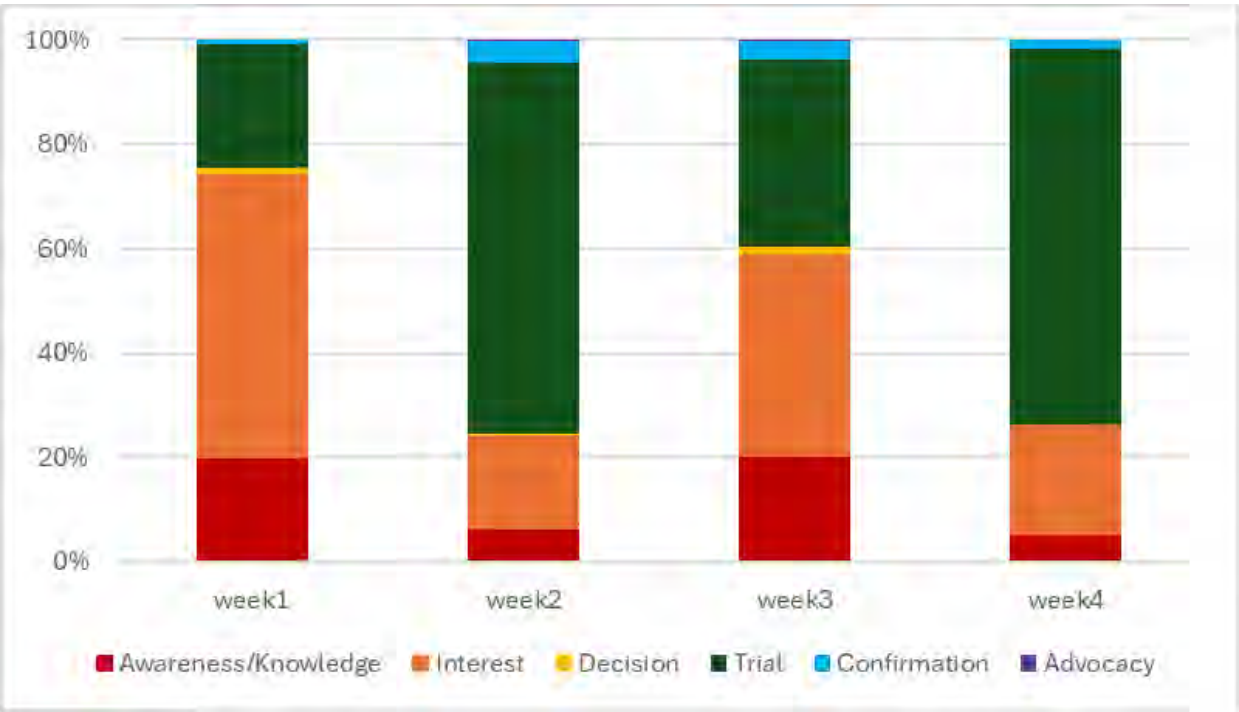
students made confirmatory decisions on applying ChatGPT to their teaching after experimenting with the tool.

In the third week, students actively shared effective strategies for utilizing ChatGPT. These strategies were supported by diverse sources or evidence, including their own knowledge (i.e., Awareness/Knowledge stage, n=135, 20.1%) or experiences (i.e., Trial stage, n=242, 36.1%). While engaging in the weekly discussions and learning from one another, they critically evaluated ChatGPT's utility (e.g., "I don't think ChatGPT is the best place to use as a resource, but it does give pretty good responses sometimes") and expressed a range of perspectives (e.g., "So if ChatGPT could be helpful to students in a tutoring type of way showing them how to do something, I'm all for that.") or personal interest (e.g., "Even though I am not an MIS major, I am still pretty interested."), as reflected in the Interest stage (n=261, 38.9%).

In the final week, they delved into discussions surrounding ethical considerations arising from their interactions with ChatGPT. Consequently, the Trial stage emerged as the most prevalent (n=472, 72.0%), indicating an intensive engagement with the AI tool to evaluate its ethical implications for their teaching and their students. Alongside this, the Interest stage also featured prominently (n=140, 21.3%), manifesting continued curiosity and exploration regarding the ethical dimensions of GenAI utilization.

Figure 2

Weekly DOI Stages Distribution Across Courses



Although students' confirmation and advocacy on the ChatGPT tool did not considerably increase over the course of the week, their anxiety regarding GenAI technologies significantly decreased after taking part in online courses related to AI. We carried out an AI anxiety survey (Wang & Wang, 2022) both before and after the courses to examine whether students' anxiety decreased as they became more familiar with ChatGPT throughout the courses. Using a two-sided paired samples t-test, we observed a significant decrease in post-test AI anxiety scores ($M = 4.5$, $SD = 1.2$, $N = 26$) compared to pre-test scores ($M = 3.6$, $SD = 1.1$, $N = 26$), $t(25) = -3.7$, $p < .001$. This result suggests that the online discussions facilitated pre-service teachers in acquiring knowledge and skills in AI technologies through direct or indirect experiences, as well as learning from and with their peers. While the majority of participants found the course to be helpful, some expressed a desire to further their understanding of GenAI and GenAI tools by enrolling in additional courses, noting, "To fully comprehend ChatGPT and its implications, I would need to participate in a semester-long course."

Pre-service Teachers' Dual Identity and GenAI Adoption Plans

Pre-service teachers have unique characteristics in that they possess multifaceted identities as both current students and future educators. These dual roles significantly shape their perspectives on adopting GenAI technology. Throughout discussions on integrating GenAI tools into the educational context, the pre-service teachers elaborated on their plans and provided examples of utilizing ChatGPT in both learning and teaching contexts (see Table 2).

Table 2

Pre-service Teachers' Plans to Apply GenAI Technologies in Educational Contexts

Plan	Example
	Learning contexts
Writing	"Most of the time, I use ChatGPT to check my grammar and punctuation." "I really appreciated using it when correcting my papers." "During the amount of time that I have used the AI application that is ChatGPT, I have come across some issues that are not bad but can be easily fixed, such as saving content that can be used for future applications and it does have extensive room for creativity which can allow me to format anything that I would like to use which is very liberating which is very good considering its an AI."
Preparing for Tests	"For example, I asked for a study plan for my upcoming Praxis exam, and it provided a detailed day and week plan that was helpful."

	"I use ChatGPT to help me study for test and make practice problems for me so I can get better at a subject that I am struggling with."
Understanding Concepts and Researching	"These coming semesters, I will definitely be using AI and ChatGPT to help me better understand concepts or just explain and answer some questions." "If I were to use AI to aid me in research, this process would be less frustrating. I could start my initial prompt, for example, "Did Thomas Edison have a formal education?". This would generate an answer. Now I could dig deeper by pretending I was having a conversation. Instead of spending an hour trying to find a credible source that answers my initial question, I can spend an hour reading about how his mother was his first teacher."
	Teaching contexts
Lesson Planning	"I am very excited for ChatGPT to help me meet standards and incorporate lessons with something I did not think of.". "I plan to continue using ChatGPT for help with assignments and future lesson plans. I noticed that the content has different ideas from what I was originally thinking, so this has expanded my thinking and deepened the lesson plan. I believe this to be helpful as it is so easily accessible and provides a variety of examples and ideas that I can choose from that best fit the lesson."
Brainstorming Teaching Insight	"It gives great ideas on themes to introduce to my PreK class. It also provides wonderful ideas to support my nine-year-old daughter in reading."

Pre-service teachers began by formulating and identifying more concrete plans for implementing ChatGPT in their own learning context. They expressed an intention to utilize the tool for various writing tasks, such as checking for grammatical errors and formatting. Additionally, some indicated a plan to employ the tool for test preparation in their other courses. For instance, two students mentioned developing study plans and creating sample assessment items to aid in their test preparation. Others also said they would utilize ChatGPT to ask questions to understand course concepts and gain knowledge, using the tool as a study and research assistant. They found it particularly beneficial as a learning tool, as they were able to engage in an iterative conversation by posing prompts and receiving answers generated by ChatGPT.

In the teaching context, they expressed their intention to use it for lesson planning and to come up with teaching insights. They pointed out that ChatGPT could suggest various ideas that they had not considered on their own. Despite these plans for integrating technology, their envisioned adoption was mainly limited to brainstorming and lesson planning. They did not explicitly state their intentions to utilize ChatGPT in the implementation or evaluation stages of teaching, perhaps indicating that they were still exploring AI adoption at a preliminary level. While many pre-service teachers recognized the potential benefits of AI tools in both learning and teaching contexts, some expressed concerns about their limited knowledge and hesitancy in adopting such tools. For example, one student stated, "I believe AI tools can help make teachers' lives easier, but I am also hesitant to explore them due to my limited knowledge." In contrast, another pre-service teacher proposed reframing AI anxiety as "curiosity and feelings of uncertainty" to foster a more open-minded approach to adopting AI tools for teaching and learning. Perceiving GenAI technologies as a double-edged sword, pre-service teachers were cautious in their decision to use ChatGPT for their students, opting for limited use cases.

Pre-Service Teachers' Perceived Benefits of GenAI Tool

As pre-service teachers started to gain their understanding and proficiency in using ChatGPT, they shared the benefits of the tool and its potential application in enhancing teaching and learning. They highlighted the advantage of quick access to information and resources, as well as the ease of obtaining answers. Upon entering questions or prompts, ChatGPT immediately generates responses within seconds. Users can then ask follow-up questions to elaborate on the previous output if needed or finish the search. This easy and streamlined process was highly valued by the pre-service teachers, as it helped them save time and assisted them in various tasks. They expressed positive attitudes about ChatGPT's ability to alleviate tedious work, such as grading, and increase productivity for both teachers and students.

Additionally, they positively viewed it as a private AI tutor, providing opportunities for personalized learning. Rather than solely relying on teachers, they said AI could satisfy diverse students' learning needs by providing appropriate materials or assisting learning at an individual's unique learning pace. One student also noted that AI could transform education by intelligently assessing students' strengths and weaknesses with real-time, individualized feedback. This is further connected to the potential benefits of diverse, equitable, and inclusive learning. For instance, one student stated, "AI-powered tools like speech-to-text and text-to-speech software, as well as real-time translation services, can help bridge language and accessibility gaps, making learning more inclusive." While some pre-service teachers expressed reservations about the reliability of ChatGPT as a source, they also proposed effective strategies for implementing the tool as a learning aid. For example, one pre-service teacher suggested the use of credible sources for verification or cross-referencing of the information generated by ChatGPT. By employing this approach, they can pose complex questions, critically analyze the responses, verify them through reliable sources, and develop a more comprehensive understanding of the topic. Despite recognizing the limitations of AI technologies, these pre-service teachers found ways to utilize ChatGPT responsibly and productively in their learning.

Another recognized benefit of using ChatGPT was its capacity to enhance writing skills and improve the quality of papers. Pre-service teachers found it to be a valuable tool for editing and refining their writing. Beyond simply correcting grammatical errors, they anticipated that

ChatGPT could assist them in achieving greater clarity and coherence in their writing. For instance, one pre-service teacher remarked, "I find AI to be particularly useful when I'm stuck and struggling to find the right words for a paper or assignment." Another pre-service teacher expressed a similar sentiment, stating, "There are times when we struggle to convey our message effectively in writing, and I believe ChatGPT can help us articulate our thoughts more clearly." These insights highlight the potential of ChatGPT to support pre-service teachers in refining their writing skills and producing higher-quality academic work for their own learning and teaching.

Pre-Service Teachers' Perceived Concerns and Challenges on Using GenAI Tool

While discussing the potential impact of ChatGPT, pre-service teachers raised concerns and challenges associated with its use. These concerns were not only related to the limited functionality of the tool but also to the manner in how people use technology. In fact, they were concerned about issues that they would need to deal with in the near future. The concern revolved around the potential for academic dishonesty, with pre-service teachers expressing apprehension about the possibility of ChatGPT being utilized for cheating by their future students. They highlighted the ease of generating responses and copying from the tool, raising concerns about its implications for academic integrity. Thus, a few pre-service teachers emphasized the importance of AI regulation and policies to mitigate the risk of misuse and ensure ethical AI use in educational settings.

This concern was extended to the potential impact on critical thinking skills and creativity, with pre-service teachers worrying that excessive dependence on AI could lead to a decline in these higher-order thinking skills. They feared that their future students might opt to use AI to complete assignments rather than study the material. As one pre-service teacher remarked, "It can lead to people not being able to think or function on their own." This concern was not limited to students alone but also applied to the broader population. Another pre-service teacher highlighted the importance of maintaining a balance and not relying solely on AI, stating, "But all faith should not be put into ChatGPT alone. We still need to be using our own research, our own knowledge, and our own hard work in our classes and in our careers. We can take help from AI, but we should never let it do the job for us."

Furthermore, some pre-service teachers emphasized concerns about biased responses generated by ChatGPT, highlighting the potential negative impact on social justice. One remarked, "In my research throughout this course, I have learned that ChatGPT and other AI programs can potentially have social, gender, and racial biases," echoing the sentiments of many others who were concerned about the possibility of generating prejudiced and stereotypical content. Additionally, they discussed the misuse of AI tools in creating and spreading misinformation. While some attributed this to the limited or outdated training data of ChatGPT, others expressed worry about intentional manipulation by individuals. Consequently, they emphasized the importance of being aware of potential biases and the lack of transparency in the way how AI technology operates. One pre-service teacher summarized as an "advocate for responsible AI development that respects accuracy, fairness, and freedom of information."

Challenges encountered while using ChatGPT primarily revolved around inadequate prompting skills. Initially, the pre-service teachers struggled to obtain desired or expected results due to inappropriate approaches. For example, some treated AI as human, requesting judgmental

responses or subjective opinions. At other times, prompts were poorly articulated, resulting in generic responses. Through practice and revision of prompts, the pre-service teachers learned to script prompts effectively, eliciting more accurate and relevant answers. One pre-service teacher reflected, "Oftentimes, it misinterprets my commands or prompts and directs me to an incorrect or partially wrong answer. This difficulty has decreased as I have learned to ask prompt questions or questions more concisely to receive a more accurate answer for whatever I am doing." Additionally, sharing effective search strategies proved beneficial. The pre-service teachers recommended chunking the problem, implementing a feedback mechanism to correct and improve ChatGPT's responses, and limiting response length.

Discussion

The present study demonstrated both quantitative and qualitative evidence which illustrates the views of pre-service teachers, delivering rich insights into the interplay between students and teachers when introducing a GenAI tool for their learning and teaching. Pre-service teachers expressed a unique dual perspective, balancing their own learning experiences with the preparation for future teaching roles, a dynamic that significantly influences their pedagogical approach (Borg, 2006; Farrell, 1999). Unlike in-service teachers, the pre-service teachers had an opportunity to utilize the GenAI tool for their own learning, including assignment submissions and discussion participation. It was notable that the pre-service teachers first experienced the tool as learners themselves before connecting their experiences with their future role as teachers. These experiences are likely to influence their intention to apply ChatGPT in their teaching, as the pre-service teachers' exposure to technology can lead to higher level of perceptions in terms of importance, helpfulness, and competence of digital technologies (Bakir, 2015; Polly, Martin, & Byker, 2023).

Based on their own experiences, pre-service teachers identified limitations associated with using ChatGPT and recognized societal and ethical issues that could arise from their use for learning (Karahan, 2023). For instance, they discussed how ChatGPT could potentially contribute to plagiarism and weaken critical and creative thinking skills among their future students. As a result of these discussions, pre-service teachers suggested implementing regulations on the use of ChatGPT to mitigate these concerns and impacts in educational settings. This process helped them reflect on how their firsthand encounters with AI tools afforded them to critically assess their pedagogical decisions for the future. Essentially, the pre-service teacher preparation courses played a pivotal role in fostering transformative learning experiences. It empowered the pre-service teachers to actively participate in the instructional discussions as active future teachers, not merely as passive students. This active engagement extends beyond personal learning experiences to include critical and practical reflections on the technological and ethical dimensions of educational tools, essential for both personal learning and future teaching practices.

However, during the discussions, pre-service teachers did not express confirmatory statements indicating they would adopt this tool for their teaching practices. This reiterates results from the previous studies that show reluctance of pre-service teachers adopting AI-related technologies (e.g., Kaufmann, 2021). Despite engaging in weekly discussions about using

ChatGPT, which increased their awareness and foundational knowledge of GenAI tools, they primarily focused their conversations on the perceived benefits, concerns, and challenges associated with using ChatGPT. This finding suggests that while they recognized the potential advantages of GenAI tools, they still showed reservations and uncertainties about integrating them into their teaching practices. Furthermore, their discussions about using ChatGPT in their courses stayed at a general learning level without delving into specific instructional plans for integrating the tool into their teaching practices. For instance, pre-service teachers concentrated on topics, such as crafting effective prompts, and shared advice based on their experiences. This could be attributed to the condensed 6-week course structure, which may not have allowed enough time for pre-service teachers to fully explore and apply ChatGPT within their instructional strategies. Alternatively, they may have lacked a practical classroom setting to actively consider or implement the tool in a meaningful way as a pre-service teacher. This focus on general aspects of using ChatGPT indicated a need for further exploration and development of concrete instructional strategies for implementation in educational settings, such as a lesson plan design activity.

Another notable finding is attributed to the perceived uncertainty that pre-service teachers demonstrated regarding GenAI tools. Despite an increase in their interest and knowledge about GenAI tools and a significant reduction in anxiety towards AI technologies by the AI anxiety pre/post survey, they still expressed uncertainty about their potential applications in classrooms, manifesting in a range of emotional responses, including both worry and excitement. This uncertainty surrounding GenAI tools' application in the classroom could be a significant barrier to their adoption for teaching and learning (Wang et al., 2024). To address this challenge, pre-service teachers may benefit from additional professional development opportunities aimed at understanding AI concepts and ethical considerations to reduce uncertainty and enhance familiarity with AI use in educational settings. Such initiatives could empower educators to confidently integrate AI tools into their instructional practices.

Lastly, for research into the adoption of GenAI tools for pre-service teachers, our findings can serve as a foundational guide for future research endeavors aimed at promoting the efficient and responsible adoption of GenAI tools within higher education environments. Employing the DoI framework can help us identify which stage students are in throughout their experiences and afford us opportunities to proactively respond to their needs (Sahin, 2012). By employing this framework, future design-based research could systematically assess and refine instructional strategies to ensure that GenAI-related course materials align precisely with pre-service teachers' readiness and openness to new technologies. This methodical approach allows for tailored interventions at each adoption stage, from raising awareness and sparking interest to facilitating informed decision-making and promoting sustained use and advocacy. Additionally, our findings underscore the significance of continuous feedback loops within pre-service teacher development courses. By tracking and analyzing pre-service teachers' adoption cycles and stages, we can tailor activities to either flexible or in-depth experiential learning as needed. This strategy not only optimizes the integration of GenAI tools in the curriculum but also maintains student engagement by encouraging them to critically assess and reflect on their experiences with these technologies.

Implications for Practice and Research and Limitations

This study explored pre-service teachers' discussion postings in an online learning setting to discover their perspectives on GenAI. In practice, analysis of the discussion postings can provide useful implications for designing and facilitating asynchronous online courses aimed at leveraging the potential of ChatGPT for pre-service teachers (Song & McNary, 2011). By analyzing the adoption stages within these discussions and examining the qualitative content, instructors can identify effective instructional strategies to integrate ChatGPT into their curriculum. In particular, the analysis can shed light on the types of prompts and activities that resonate most with pre-service teachers when utilizing ChatGPT, highlighting successful approaches for fostering meaningful engagement and learning outcomes. Additionally, this study could reveal challenges and barriers encountered by pre-service teachers, informing adjustments to course design and facilitation methods to optimize the use of GenAI tools like ChatGPT in educational contexts. For example, it was insufficient for students to simply adopt ChatGPT for their teaching only with the weekly discussions; it required deliberate, authentic assignments that allowed them to intentionally leverage the tool in their teaching practice (e.g., a scenario that requires adjusting reading levels and multilingual teaching context). Furthermore, insights gained from the analysis can inform the development of best practices and guidelines for instructors seeking to incorporate AI tools into asynchronous online courses. By understanding how to structure discussions, provide support, and scaffold discussions around ChatGPT, instructors can create more effective and enriching learning experiences that enhance pre-service teachers' proficiency and confidence in utilizing AI technologies.

Although this study contributed to a deeper understanding of the pre-service teachers' experiences using ChatGPT, important questions remain. Because this study investigated one instructor in one institution, we need to expand our study to multiple institutions with more instructors to establish diverse learning contexts. With a larger sample size and instructors, researchers could become more confident about the findings representing the experiences of pre-service teachers in general, not just those at this specific institution. In addition, the participants' experiences may have been influenced by the specific course structure, curriculum, and the instructor who designed and implemented the courses. Future research could explore how these contextual factors shape pre-service teachers' discourse on and perceptions of GenAI tools in classrooms. These limitations highlight the need for further research. Additional studies with larger and more diverse samples across multiple institutions would strengthen the validity of the current findings. By replicating the study in different contexts, researchers can determine if the observed uncertainty surrounding GenAI tools is consistent across different pre-service teacher programs and design effective teacher professional development programs.

Conclusion

AI is not going anywhere, so it is our job to help students understand how to use it responsibly. Discussions surrounding ChatGPT within the courses contributed to a notable increase in pre-service teachers' awareness and foundational knowledge as well as a meaningful decrease in anxiety towards AI technologies. However, despite their exposure to ChatGPT during the courses, only a minority of participants confirmed intentions to adopt GenAI tools in their learning or teaching practices. Moreover, their contributions in discussions predominantly remained at a general level, lacking specific plans for integrating ChatGPT into their lessons.

This may be indicative of uncertainties surrounding the application of GenAI in educational contexts, as evidenced by a range of emotional responses, including feelings of uncertainty and concern. Professional development opportunities targeting AI literacy could play a pivotal role in addressing these uncertainties and enhancing familiarity with GenAI technologies among pre-service teachers. Moving forward, the findings from this study will contribute to providing valuable insights into the effective and responsible adoption of GenAI tools in educational settings. Additionally, the study aims to shed light on how higher education institutions can strategically leverage ChatGPT to enhance the learning experiences of pre-service teachers.

Conflict of Interest Statement

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

Ethical Approval

All procedures followed were in accordance with the ethical standards of the Human Subjects & Institutional Review Boards. Informed consent was obtained from all individual participants who were included in the study, and they were informed they could elect to withdraw participation at any time.

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