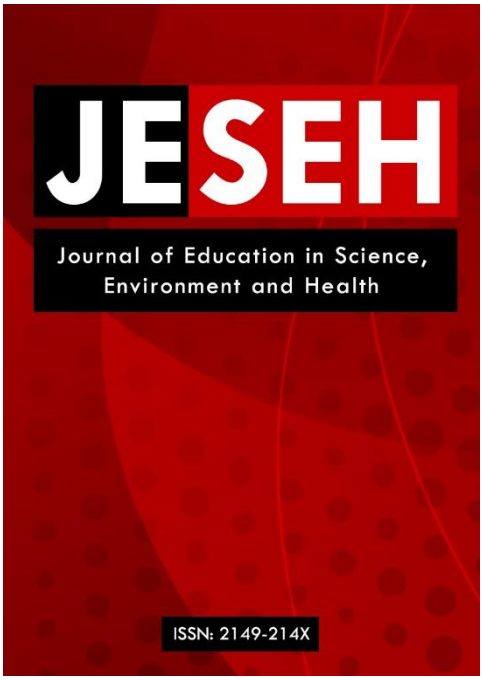

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Abstract

Artificial intelligence (AI) in science education offers significant advantages to pre-service teachers in lesson planning, developing teaching resources, and implementing personalized learning. Simulations, visualizations, and intelligent assessment systems contribute to the concretization of abstract concepts and increased student participation. This phenomenological study aims to determine preservice science teachers' views on AI. To this end, semi-structured interviews were conducted with 13 preservice teachers from different grade levels who had prior experience with AI, including virtual laboratory applications. A semi-structured interview form was used for this purpose, and the data were evaluated using content analysis. Strategies such as in-depth data collection, expert review, and member check were employed to ensure internal validity. The findings indicate that preservice teachers view AI as a tool that supports lesson planning and teaching processes. However, they also believe that excessive reliance on AI may limit teachers' creativity. Participants' views were grouped into the following categories: AI use in educational processes, the effects of AI on students, reliability, and the role of the teacher. One emerging finding is that preservice teachers often do not verify the information they obtain from AI. The study highlights the potential of AI as a pedagogical tool in science education and the factors teachers should consider when using AI.

Introduction

In the 21st century, rapid technology-driven developments have led to fundamental transformations in education systems. Web 2.0 technologies and advances in AI have reshaped learning and teaching (Baidoo-Anu & Ansah, 2023). During this transformation, as machine learning and deep learning-based systems have advanced, generative artificial intelligence (GenAI)—a subset of AI focused on creating content—has emerged, and the importance of innovative applications in education has increased (Tyson & Sauers, 2021). GenAI tools can produce meaningful, contextually relevant, and human-like text, images, and other digital content in response to user input (Söğüt, 2024). In this regard, GenAI has the potential to generate knowledge and offer personalized learning experiences in teaching. GenAI learns patterns from large datasets using statistical and probabilistic models, enabling it to generate original content based on these patterns (Baidoo-Anu & Ansah, 2023). Advances in AI technology have enabled these tools to analyze multiple data types, such as text, audio, images, and video; understand complex structures; and produce content based on this analysis. AI-based tools provide preservice teachers with access to information, assist them in developing teaching resources, and offer personalized support according to their individual learning needs (Nyaaba et al., 2024). These features have made AI a valuable learning tool, supporting preservice teachers' academic development and strengthening their research, inquiry, and production skills (Lee & Zhai, 2024).

Research in teacher education has focused on preservice teachers' awareness (Akanzire et al., 2025). Preservice teachers will play a key role in future educational environments, going beyond mere information conveyors to become learning facilitators integrating technology with pedagogy. In this context, it is worth noting that preservice teachers' attitudes towards GenAI tools are closely related to how useful and easy these tools are perceived to be (Yang & Chen, 2023). For instance, AI-supported applications can visualize abstract scientific concepts, thereby deepening conceptual learning and facilitating meaningful learning for students. This perceived benefit may encourage preservice teachers to use AI tools more willingly. Teachers' views largely determine whether technological tools will be used in the classroom. The increasing awareness and usage of GenAI applications, such as ChatGPT, Google Bard, and DALL·E, indicate that preservice teachers recognize the potential of these technologies in education (Alhumaida et al., 2022; Nyaaba et al., 2024). Furthermore, it has been suggested that these tools could significantly support students by providing feedback, evaluating their learning, and designing instruction to meet their individual needs (Yıldırım & Akçan, 2024). This situation has

made it vital to examine preservice teachers' views, opinions, and experiences with these technologies in their scholarly and professional practices (Alhumaida et al., 2022; Nyaaba et al., 2024). As preservice teachers will be at the center of education, it is strategically important to thoroughly examine preservice science teachers' perceptions of GenAI, not only to understand current technological developments but also to shape future teaching models. Such an investigation would provide valuable insights into the practical, ethical, and pedagogical use of AI in education (Aldosari, 2020; AlKanaan, 2022). In this regard, the present study aims to examine preservice science teachers' views on AI and to develop recommendations for integrating these technologies into teacher education.

Theoretical Framework

This section provides a thorough review of the use of artificial intelligence in educational settings, particularly in science education, and of how it is discussed in existing literature.

Artificial Intelligence in Education

AI holds significant potential to revolutionize personalized learning, lesson preparation, and research for preservice teachers (Li & Ironsi, 2024; Nyaaba et al., 2024). For instance, Li and Ironsi (2024) highlighted the advantages and disadvantages of utilizing AI in education. It has been stated that AI is useful for mathematical operations in education but is generally insufficient for large groups due to cost, ethical concerns, usability issues, and other factors (Yavuz-Bostanci et al., 2025; Zhai et al., 2021). Numerous AI technologies are designed with a wide-ranging focus, thereby failing to address the specific instructional practices or educational goals of particular domains. (Lee et al., 2023). However, integrating AI technologies can enable personalized distance learning, especially in regions experiencing teacher shortages, where a single teacher can instruct students from multiple regions online. This enables students to interact with expert instructors and take advantage of learning opportunities (Li & Ironsi, 2024). Furthermore, advanced homework systems powered by AI can autonomously evaluate students' assignments from various locations, enabling educators to personalize instruction for each learner (Azad et al., 2020). The capacity of AI to augment personalized learning is a persuasive justification for incorporating these technologies into education, facilitating a more individualized and effective learning experience for students.

Teachers' and pre-service teachers' attitudes towards AI influence their use in education (Li & Ironsi, 2024). Inadequate, misguided, aimless, or outdated professional development programs may cause teachers to either reject AI completely or become overly dependent on it. Therefore, relevant, up-to-date, and effective professional development programs are needed to enable teachers to use AI consciously and in a balanced manner (Mnguni, 2025). Teachers should learn how to use AI as an educational tool and apply it in a balanced way, without becoming overly dependent on it or rejecting it entirely. Teachers play a crucial role in teaching AI literacy (Park et al., 2023). Nevertheless, since many educators lack AI expertise and are already constrained by their existing teaching tasks, it might be difficult for them to evolve into AI-literate instructors. Integrating AI into the curriculum requires teachers to make a significant effort. AI enables teachers to implement personalized learning and practical assessment methods in their lessons. Developing AI literacy among teachers and pre-service teachers is a critical step towards successful educational transformation (Azad et al., 2020). Science education inherently involves many abstract concepts, so AI technologies have significant potential to present these concepts to students in more concrete, understandable ways. The ability of AI to make these abstract concepts more accessible and easier to understand is a fascinating aspect of its potential in education (Holder et al., 2018). Science education often requires students to understand natural phenomena and processes that they cannot directly experience or observe (Hamed, 2025). Such abstract information can be challenging to learn using traditional methods. However, AI technologies, particularly simulations and visualizations, can make these concepts more accessible and easier to understand (AlKanaan, 2022).

Artificial Intelligence in Science Education

The acceptance of new educational reforms depends on the attitudes of science teachers (Lee & Zhai, 2024). Teachers who are resistant to technology and prefer traditional methods may find integration of AI tools into the classroom problematic (Bizim et al, 2025; Darayseh, 2023). This can lead to a prejudiced approach to technology and resistance to change. However, the use of AI in science education does not guarantee practical application or

improved teaching quality (Mnguni, 2025). For AI to fully demonstrate its potential benefits in science education, teachers must be prepared to use this technology effectively.

Integrating artificial intelligence tools into science education can significantly improve teaching methods (Darayseh, 2023; Lee & Zhai, 2024; Yılmaz, 2024). Teachers benefit from these tools, as they make classroom interactions more efficient and provide personalized education. Using AI in science lessons can stimulate students' interest and motivation and improve their learning (Yılmaz, 2024; Konstantinos, 2025). For instance, AI systems can analyze student responses in real time, providing rapid, personalized feedback tailored to each student's level of understanding. This is particularly important in subjects such as science, where grasping abstract concepts is essential (Kim & Kim, 2022). AI can adapt materials to students' learning styles, enabling them to progress at their own pace (Almasri, 2024). Furthermore, AI enables students to better understand scientific concepts by providing safe, interactive experiences through virtual laboratories and simulations (Ibáñez & Delgado-Kloos, 2018). GenAI also facilitates the exchange of scientific ideas between students and teachers from different regions, fostering a global perspective (Almasri, 2024; Deveci Topal et al., 2021).

However, the success of this process relies on teachers' ability to select and use these technologies effectively (Mnguni, 2025). Teachers' attitudes towards technology and their knowledge are crucial to its successful use in education (Lee & Zhai, 2024). Teachers' behavioral intentions regarding AI adoption are important for determining the potential of AI-supported instruction in science education and the future direction of educational technologies (AlKanaan, 2022). Generally, individuals have limited awareness of and understanding of AI applications in science education (Kim & Kim, 2022). Some teachers recognize the benefits of AI but lack knowledge of it in education (Yilmaz, 2024). These issues hinder teachers' ability to use AI in education and prevent its widespread adoption in science classrooms (Rana et al., 2025). AI-supported simulations can improve teaching by offering teachers and preservice teachers more effective teaching methods. Teachers can use AI-supported simulations to improve their teaching skills and adopt more innovative, practical methods in science education. Mnguni (2025) noted that participants had mixed attitudes: they believed that AI is pedagogically beneficial but expressed concerns about its effectiveness (Kim & Kim, 2022).

AI-supported science education is an important tool for developing pre-service teachers' teaching skills (Cooper & Tang, 2024; Zhang et al., 2024). Darayseh (2023) reported in his descriptive study that science teachers highly accept AI, and that this level of acceptance is related to self-efficacy, ease of use, perceived usefulness, and attitudes towards AI. Kim and Kim (2022) stated that while AI applications can limit thinking, teachers who use these applications broaden thinking by providing sources that support their claims in class and by reflecting participants' expectations and concerns about AI. Furthermore, themes such as support, difference, learning, teacher role, and transparency stand out (Ayanwale et al., 2024). Deveci Topal et al. (2021) taught science concepts through AI-supported chatbots. The research results revealed that this positively affected students' experience of AI-supported online learning. Students evaluated the chatbot as a valuable, enjoyable, and easy-to-repeated learning tool. Haseski (2019) examined preservice teachers' views on AI, revealing that they have mixed feelings about it and do not want to live in a world managed by AI. Furthermore, preservice teachers believe that AI carries both benefits and risks in education and can have positive and negative effects (Nyaaba, 2024). Therefore, activities such as research, experimentation, and observation should be encouraged, particularly in fields such as technology and science (Kartal, 2024).

Kim and Rachmatullah (2025) argue that teachers have integrated AI into science education in three ways: as a digital tool, an inquiry partner, and an epistemic system. These approaches have enabled students to develop basic AI skills, as well as scientific thinking and ethical awareness. The study demonstrates that AI can be used in science education across technical, knowledge-production, and critical-thinking contexts. Lee and Zhai (2024) examined lesson plans developed by pre-service teachers using AI. Concerns were raised in this context about the accuracy of AI-supported science lesson plans and the risk of students becoming overly dependent on ChatGPT. Furthermore, they proposed solutions for more systematically organizing classroom dynamics between teachers and students. Yılmaz (2024) noted the various advantages of AI in science education, such as the creation of virtual environments and its ability to increase inclusivity, strengthen motivation, and create personalized learning environments. However, he also emphasized that AI-supported science teaching has various disadvantages. These include dependence on technology, data privacy and security issues, infrastructure requirements, the need for teacher training, access inequality, and a reduced human touch.

The use of AI in science education can increase students' motivation to learn and participation (Konstantinos, 2025). However, teachers' perceptions of this technology and their level of preparation to use it are critical factors in determining the success of this process (Darayseh, 2023). Science teachers' hesitant attitudes towards AI tools stem from a lack of awareness and preparation (Mnguni, 2025). This has the potential to hinder the full benefits

of technology in education from being realized. Teachers require sufficient knowledge and skills to use AI-supported teaching tools effectively (Li & Ironsi, 2024). This study is essential for examining preservice teachers' views on AI and the factors that will directly affect the success of integrating these technologies into teaching processes.

Method

Research Design

This phenomenological study aims to gain a deeper understanding of preservice science teachers' experiences when using AI-supported applications in innovative teaching environments and the meanings they assign to these experiences. The phenomenological approach focuses on describing how individuals perceive, feel, and interpret a phenomenon (Creswell & Poth, 2016). This study provides an important framework for understanding how preservice science teachers make sense of their beliefs and perceptions of personal efficacy regarding technology, science, and instructional processes through their experiences with GenAI. This study can contribute both theoretically and practically to the role of artificial intelligence-based learning environments in science teacher education programs.

Participants

The participants were selected using a purposive sampling method, which consciously selects individuals who can provide in-depth information about a specific phenomenon (Patton, 2014). In this context, the key criterion was that participants were students in the science education teacher education program who had experience with artificial intelligence-supported virtual laboratory applications. The participants were 13 pre-service science teachers studying in the second, third, and fourth years of the science education teacher education program at a state university's Faculty of Education in the Central Anatolia region of Turkey. This approach aimed to enrich and enhance the representativeness of participants' data and to explore the phenomenon across multiple dimensions, thereby contributing to a multifaceted understanding. Of the preservice teachers, six (one male and five female) were in the second year, four (two male and two female) in the third year, and three (all female) in the fourth year.

Data Collection Process

Participants at different grade levels took courses on virtual laboratory applications. While studying the theoretical content, preservice teachers also had the opportunity to practice in virtual laboratories. These laboratories enabled them to simulate physical experiments in a digital environment, reinforcing their theoretical and practical knowledge. AI-supported tools not only helped preservice teachers perform experiments but also provided feedback on procedures conducted in the virtual environment, thereby helping personalize the teaching process. Through this process, preservice teachers integrated theoretical knowledge with virtual laboratory practices, gaining a deeper understanding with the support of AI. Following this experience, qualitative data were collected through semi-structured interviews to examine the preservice teachers' attitudes and opinions in greater depth. Preservice teachers were informed about the study, and participation was voluntary. The interviews took place in a comfortable environment at a time chosen by the participants. The interviews lasted between 30 and 45 minutes. Lincoln and Guba (1985) stated that credibility is a crucial criterion in qualitative research and that several steps must be taken to achieve it. These are: i) prolonged engagement; ii) in-depth data collection; iii) expert review; and iv) participant confirmation. The data collection process, analysis, and reporting were carried out under the supervision of field experts. Additionally, immediately after the interviews, researchers made preliminary interpretations based on notes taken during the interviews and later confirmed them with the participants. These strategies are among the most important factors in ensuring the validity of a qualitative study.

The data were collected through semi-structured interviews, specifically designed to align with the research objectives and structured around open-ended questions to gain in-depth insights into participants' experiences and perspectives. This allowed the researchers to guide discussions on specific themes while enabling participants to express their experiences freely (Tisdell et al., 2025). During the interviews, the primary researcher aimed to reach the core of the participants' experiences through pre-determined questions and employed probing follow-up questions as needed (Seidman, 2006). A conducive environment was established to facilitate comfortable expression, and participation was voluntary. A voice recording device was used to ensure the integrity and

accuracy of the data collected. The recordings were subsequently transcribed in detail to prepare for analysis. The transcriptions maintained the authenticity of the participants' statements. To analyze the data, MAXQDA software was used, known for enhancing the systematic and transparent nature of qualitative research.

Interview transcripts were first transcribed verbatim, and researchers identified units of meaning by repeatedly reading the texts. These units of meaning were then coded, and themes and categories were created by grouping similar meanings. This resulted in a comprehensive description of the essence of the phenomenon (Patton, 2014). To avoid bias and deepen their understanding of participants' experiences, researchers adhered to the bracketing principle (Creswell & Poth, 2016). In addition, to increase the reliability of the analysis results, feedback was obtained from participants (member checking), making them active participants in the research. Researchers also conducted the analysis independently, ensuring diverse perspectives. At the end of the study, the coders met to compare codes, fostering collaboration. When differences arose between coders, a mutual discussion was held, and the process continued until 100% agreement was reached. Codes on which consensus could not be reached were not included in the study (Miles & Huberman, 1994). This method increased the reliability of the analysis process and strengthened the scientific validity of the study's findings.

Results

This section presents the findings from the content and descriptive analysis in the format of codes, categories, and quotations. Table 1 illustrates preservice teachers' views on artificial intelligence and educational processes.

Table 1. Artificial intelligence and educational processes

Category	Definition	Sample quotes
Planning and Preparing Teaching Resources	Preservice teachers' use of artificial intelligence to develop lesson plans and enrich teaching resources	*"So, I think it makes our lives easier. It provides lesson plans and content, creates visuals, and outlines how to proceed."* *"I was going to talk about force. I asked the AI how to introduce the topic. It had me design an activity involving Play-Doh."* *"I need to teach a class during my student teaching. When I ask the AI about that, it gives me some great ideas."*
Applications for Artificial Intelligence	Applications of artificial intelligence in education, such as preparing teaching resources, visualization, and virtual laboratories	*"I use artificial intelligence by conducting simulations, performing experiments, and implementing virtual laboratories."* *"It can draw graphs for you or directly present a lot of details or examples for you."* *"It can show the stages of mitosis and create those visuals and diagrams for me."* *"I believe it will be much more useful in situations where physical experiments are unlikely to be conducted."*
Student Participation	The impact of artificial intelligence on interest in the science course and student participation	*"I think it will negatively affect student participation."* *"Students are becoming more enthusiastic and motivated."* *"When I give students a prompt, they will already be engaged in a kind of research."*
Prompt Writing	Experiences regarding how to formulate queries to obtain more accurate and detailed responses from artificial intelligence	*"I ask questions with question marks, begging for answers, and that way I get more responses."* *"I want to set some limits on certain things. He, on the other hand, asks for things. His answers are more detailed, while mine are more superficial and briefer."* *"I try to write in more detail each time to get more detailed information."* *"I explain my students' situation according to the class I am entering; I want him to provide content... I even give details like this: I elaborate so that when my teacher asks, he will not realize I had AI do it; I guide him in terms of content."*

As shown in Table 1, pre-service teachers perceive artificial intelligence as a tool that can facilitate and enrich the educational process. They stated that it helped them to complete time-consuming tasks, such as lesson planning and preparing teaching resources, more quickly and creatively. They also indicated that they had used it to assist with such tasks during their teaching experience. For instance, one participant said, *"I need to teach a class during my student teaching. When I ask the AI about that, it gives me some great ideas"*, demonstrating that they found AI helpful for generating preliminary ideas. Another participant described their approach, saying: *"I explain my students' situation according to the class I am entering; I want him to provide content... I even give details like this: I elaborate so that when my teacher asks, he will not realize I had AI do it; I guide him in terms of content."*. This indicates that preservice teachers provide supplementary prompts to ensure that the content does not appear to have been created by AI. Furthermore, AI is also used to create engaging lesson introductions and research-focused tasks to increase student participation. Additionally, it is possible to note that participants developed skills such as 'prompt engineering' to produce higher-quality output. This highlights their efforts to use technology more consciously and effectively. It is also noteworthy that preservice teachers give AI polite and directive commands to make the content more detailed and accurate. Table 2 presents the preservice teachers' opinions on the effects of artificial intelligence on students, as revealed by data analysis.

Table 2. The effects of artificial intelligence on students

Category	Definition	Sample quotes
Creativity and Imagination	The potential of artificial intelligence to increase or decrease students' creativity and imagination	*"It hinders creativity."* *"It definitely affects and degrades students' creativity."* *"I think artificial intelligence is very creative; it can come up with very different things based on something I say or a command I give."* *"This brings out something far beyond my imagination."*
Thinking Skills	The impact of artificial intelligence on students' critical thinking and problem-solving skills	*"I think it will take away our ability to think creatively and critically."* *"I think it will prevent us from thinking more straightforwardly...."* *"Artificial intelligence... is hindering our thinking."* *"It will slow down our problem-solving skills."* *"We do not question; we do not scrutinize. We do not think about whether it is right... I do not think it will develop many skills; it will have a negative impact."*
Encouraging Complacency and Laziness	The risk that artificial intelligence may lead to accepting information without questioning it, and adopting a complacent approach	*"I think it makes our lives easier, but on the other hand, it also seems to lead to laziness."* *"For example, we used to go to the library or do research when we had homework. However, now, even I can ask artificial intelligence almost anything right away"* *"We are taking the easy way out, myself included... I often use the information as it comes, and I think it makes us lazy."* *"People can become a bit, excuse me, foolish, whether they want to or not."*

Table 2 shows that preservice teachers are seriously concerned about the potential negative effects of AI. While AI is seen as offering opportunities to support and develop imagination, pre-service teachers also perceive it as a threat that could hinder students' cognitive skills, such as creative and critical thinking and problem-solving. In this context, pre-service teachers emphasize that AI support may limit students' thinking and make learning more superficial. For instance, one pre-service teacher stated, *"I think it will take away our ability to think creatively and critically."*, suggesting that AI could eliminate the cognitive skills of both teachers and students. One pre-service teacher, for instance, stated that *"I think it will take away our ability to think creatively and critically*," in reference to artificial intelligence as a tool that can limit educators' and students' cognitive abilities. Similarly, a significant number of participants noted that AI carries the risk of creating a *'shortcut mentality*' and a '*ready-made approach'*. This situation could result in students becoming mentally lazy in the long term, as they may become discouraged from making the effort. Indeed, one pre-service teacher shared their own experience: "*We are taking the easy way out, myself included... I often use the information as it comes, and I think it makes us lazy*." This example clearly shows that overconfidence in AI poses a risk not only to students but also to pre-

service teachers. Pre-service teachers' views indicate that AI has a dual impact on the students. On the one hand, it is seen as a tool that supports and facilitates learning. On the other hand, it is perceived as a threat that could undermine individuals' ability to think for themselves. Therefore, participants are concerned that uncontrolled use of AI in the classroom could have negative consequences, such as reducing the mental productivity of both students and teachers. On the one hand, AI is seen as a supportive and facilitating learning tool; on the other hand, however, it is perceived as a threat that could undermine individuals' authentic thinking. Table 3 presents pre-service teachers' views on the final category that emerged from the data analysis: reliability and the role of the teacher.

Table 3. Artificial intelligence, reliability, and the teacher's role

Category	Definition	Sample quotes
Accuracy and Reliability of Information	Verifying the accuracy of information provided by artificial intelligence and the uncertainties surrounding this issue.	*"Sometimes it provides incorrect information, and I have noticed that too."* *"We are not sure whether the information is correct."* *"Artificial intelligence can present information it has received from someone else as if it knew it itself, which is a very serious and unethical situation."* *"I do not think I can determine whether content from artificial intelligence is accurate."* *"If it is something I care deeply about, I check it; if it is a weekly assignment, however, I generally do not check for accuracy or errors."*
Teacher Role and Responsibilities	The teacher's responsibility for guidance and control in the use of artificial intelligence	*"Our education system wants us to be guides. I think I will serve as a guide in artificial intelligence as well."* *"How will you verify the accuracy of the image it creates? I will take on that role here too; as their teacher and guide, I will show them the way in the classroom."* *"I actually think artificial intelligence could be much better in the hands of teachers rather than students."*
Artificial Intelligence Education	The need for training for teachers and preservice teachers to effectively use artificial intelligence	*"I would really like every teacher to use artificial intelligence and for students to explain it, that is, to actively apply it."* *"I think preservice teachers really need to be informed about this."* *"There is talk of making artificial intelligence education a compulsory course in undergraduate education."* *"You can get training on this subject on its own. Not as part of a course, but short training courses can be taken over a period of a month."*
The Future of Artificial Intelligence	The potential benefits and challenges of AI in science education	*"I think it will play a crucial role in science education."* *"I believe it will be at a much more advanced level in 10 years."* *"I think it is a somewhat stalled issue in our country."* *"Since I prefer the traditional approach, I do not think the use of artificial intelligence will have much impact on science classes."* *"I think that in the future, we may not even be guides anymore."*

Table 3 shows that pre-service teachers are concerned about the reliability of information and the ethical issues that arise from the widespread adoption of AI. Participants stated they cannot always verify the accuracy of information generated by AI, suggesting that the use of such tools poses significant ethical risks. The statement

'Artificial intelligence can present information it has received from someone else as if it knew it itself, which is a very serious and unethical situation' suggests that AI poses a risk similar to plagiarism in the production of information. This phrase emphasizes how pre-service instructors are now discussing the dependability of AI. In this context, the teacher's guiding role is emphasized. Pre-service teachers stated that AI alone is not a sufficient learning resource and that teachers need to guide students to make the most of this tool. One participant expressed this view as follows: "*Our education system wants us to be guides. I think I will serve as a guide in artificial intelligence as well*." This statement reveals that participants view teaching as both the transmission of knowledge and the guidance of learning processes. The pre-service teachers also stated that compulsory courses or short-term training should be provided during undergraduate education to ensure the correct use of AI tools. This demonstrates that the ability to use technology consciously must become an integral part of the teaching profession. Participants' expectations for the future vary. One group believes that AI will transform subject teaching, particularly in science. However, another group is concerned that the traditional structure of the education system may limit this potential, leaving the opportunities offered by AI underexploited. This situation reveals that pre-service teachers are seeking a balance between their expectations and concerns about artificial intelligence.

Conclusion and Discussion

This study examines pre-service science teachers' views on AI, including a group of participants from second, third, and fourth grades at a university in the Central Anatolia region of Turkey. Participants were selected based on their previous experiences with artificial intelligence and virtual laboratory applications. The views of pre-service science teachers on AI revealed a multidimensional understanding of its applications in education, its impact on pre-service teachers, and its implications for their roles and expectations. The participants' responses clearly demonstrate the opportunities and potential risks presented by AI. This suggests that pre-service teachers view AI not only as a time-saving tool but also as a supportive element that fosters creativity and enhances pedagogical processes. While AI reduces the workload for lesson planning and material preparation, it provides pre-service teachers with different perspectives and creative ideas through features such as content delivery, visualization, and activity design. Similarly, Avşar Erümit and Yılmazer (2024) found that ChatGPT helps pre-service teachers, especially in idea generation and the development of digital materials. Abualrob (2025) found that pre-service teachers primarily use AI for lesson plans, teaching materials, assessments, tables, pictures, drawings, and teaching strategies. Perceiving AI as an additional tool, particularly when encountering material deficiencies during student teaching and lectures, encourages pre-service teachers to adopt a more flexible and creative approach to pedagogical processes. This finding highlights the importance of using AI as a supportive tool in teacher education. According to Yılmaz Can and Durmuş (2024), AI can enrich lesson planning by offering creative and differentiated approaches and by facilitating the development of assessment criteria and rubrics that align with lesson plans.

In their study examining the ability of AI to plan lessons and prepare teaching resources, Kahraman and Kıyıcı (2025) evaluated ChatGPT-generated lesson plans using a question-based lesson plan rubric. Their findings suggested that the lesson plans generally received moderate to high scores. However, the study emphasized that, when it came to providing feedback and determining where to start the lesson, the prompts needed to clarify the existing curriculum trends. The findings of this study stressed the importance of the effective use of prompts. Participants learned how to structure prompts to elicit accurate, detailed responses from AI. The form of the question, the language used, and the level of detail all directly affect the quality of the response. Some participants stated that they received more effective responses when they communicated with AI as they would with a human, using a polite or respectful style. They also mentioned a previous experience in which two people gave the same command in different styles from different devices at the same time. They observed that the AI provided more accurate and detailed responses to the person who used a more polite prompt. Abualrob (2025) stated that prompts can enhance the effectiveness of AI-generated outputs by eliciting creative ideas from pre-service teachers. This suggests that pre-service teachers need to develop new skills, such as prompt writing, to use AI effectively in teaching. Hamed et al., (2025) found that prompts were more explicit, detailed, and instructive in the teacher role than in the student role. In other words, they had greater control over the content in the teacher's role. Participants obtained high-quality responses from AI by using clear, detailed prompts and created multiple representations (such as visuals, tables, and graphs) to explain concepts. The findings revealed that the ability to create prompts is a critical skill in teacher education, supporting the learning process when interacting with AI.

Participants indicated that AI can be advantageous in practical applications, such as virtual laboratories, simulations, and the development of visual resources. They emphasized that AI could play a supportive role in education when physical experiments are not possible. This demonstrates that technology can support learning

processes, particularly given the experimental and observational nature of science education. Similarly, Pope et al. (2025) found that pre-service teachers preferred AI for visualizing abstract concepts. Cooper and Tang (2024) also stated that visualization facilitates understanding of abstract concepts in science education and promotes conceptual learning. AI-supported visuals attract students' attention and facilitate long-term learning by making microscopic processes, experiments, and scientific events more tangible.

Pre-service teachers have stated that AI can increase both interest in lessons and student participation. It can be said that pre-service teachers perceive AI as a motivating and interactive tool in the learning process. AI applications that offer personalized content, gamification, and instant feedback can engage students and encourage participation in the lesson. These findings reveal that pre-service teachers generally have a positive attitude towards AI and regard it as an important pedagogical opportunity. However, this positive perception may be influenced by factors such as access to technology during implementation, teachers' digital literacy, and the compatibility of AI tools with pedagogy. Preparedness and willingness to use AI increase pre-service teachers' engagement with AI applications (Ayanwale et al., 2024). AI-supported tasks or prompts given to students motivate them to conduct their research and inquiries. This demonstrates that AI can function as both a teacher-centered tool and a student-centered one. Pope et al. (2025) stated that AI applications make abstract concepts concrete through visualization, thereby deepening students' understanding and supporting their learning motivation. Ayanwale et al. (2024) also found that a positive attitude towards AI increases pre-service teachers' participation in AI-related educational activities and their sense of self-efficacy.

Pre-service teachers noted that the impact of AI on students' creativity and critical thinking skills is mixed. While some mention that AI can generate creative ideas and boost imagination, others express concern that it may restrict students' thinking processes and promote laziness by relying on ready-made information. These perspectives highlight the need for careful planning in the pedagogical use of AI and underscore the importance of teacher supervision. In their study, Habib et al. (2024) stated that AI allows for the rapid generation of numerous ideas, which students enjoy during brainstorming and initial idea generation. However, they also found that some students worry that AI might take over the thinking process and limit their individual creativity. This underscores the importance of using AI as a supportive tool in creative tasks and raises awareness that excessive dependence on technology could weaken students' thinking skills. After the pandemic, students used technology more than before, making them more reliant on it (Şeker et al., 2023). Consequently, the question of how, in what manner, and for what purposes AI should be used in education has become a key area of discussion. Rana et al. (2025) stated that, when thoughtfully integrated, AI can support students' creativity, critical thinking, and ethical reasoning.

Pre-service teachers have stated that information generated by AI is not always reliable and that they cannot be sure of its accuracy. The fact that AI sometimes produces incorrect or incomplete information raises not only technical problems, but also ethical and pedagogical concerns. This situation highlights the need for teachers to critically evaluate their teaching and support their students in doing the same. Furthermore, some pre-service teachers mentioned that they felt the need to verify information. They described this process as follows: If a topic needs urgent attention, they use the information without verifying its accuracy, but if they have more time, they verify the accuracy of information obtained from AI. They still tend to use AI unconditionally, even if they are concerned about the reliability of information. Here, the issue of the source of knowledge raises epistemological concerns. This is because, although pre-service teachers have taken courses such as 'The Nature of Science' and can question the source of the knowledge, they do not seem to critically evaluate or verify information obtained from AI when necessary. Determining the relationship between technology and epistemology is of great importance (Kartal et al., 2022; Kartal, 2024). Furthermore, participants argued that they should be taught about AI through informative courses integrated into teacher education programs. Indeed, Ramnarain et al. (2024) found that, while preservice teachers were willing to use generative AI tools, they had serious concerns about the accuracy of the information produced by these tools. Participants emphasized that providing incorrect information could lead to misconceptions and faulty learning among students (Bizim et al, 2025). Similarly, Lee and Zhai (2024) highlighted examples of ChatGPT misuse in lesson planning, such as the use of invented internet sources and technically unsupported visual prompts. These findings demonstrate the importance of teachers using AI alongside critical scrutiny and pedagogical adaptation, rather than as a direct source of information.

Participants emphasized that AI should only be used as a classroom tool and that teachers should continue to provide guidance. Participants said that the teacher's role as a guide is one of the goals of the MoNE curriculum. They also said that teachers should take a leadership role in the use of AI. However, some stated that, even with AI, teachers would not be able to play a guiding role in the future (Yavuz-Bostanci et al., 2025). They also mentioned that Turkey lags behind in AI development. It is possible to say that this may be why they still prefer traditional methods. Teachers are responsible for verifying information, guiding students, and supporting the

learning process. This finding suggests that AI should support teachers in their roles rather than replace them. Similarly, Nyaaba (2024) emphasized that AI plays multifaceted roles, directly addressing resistance to change, increasing access to resources, and supporting teachers' professional development. In their study, Liu and Wang (2020) stated that AI will support teachers in planning, but the main task will remain teacher-centered.

According to these findings, pre-service science teachers view AI as a creative, motivating, and supportive educational tool. They state that it reduces the workload associated with processes such as lesson planning, preparation of teaching resources, and visualization. However, they emphasized that information produced by AI is not always reliable and drew attention to the importance of accuracy control. The tendency to use information without verifying it, especially in time-critical situations, suggests a limited understanding of knowledge. Teachers should use AI as a complementary tool in guidance and pedagogical adaptation processes, developing new skills such as prompt writing and critical evaluation. In conclusion, while AI offers opportunities in education, the need to maintain teacher guidance and a critical approach comes to the fore.

Limitations and Recommendations

Pre-service science teachers' views on AI revealed that it presents both opportunities and risks in education. This study examined these views through qualitative interviews and content analysis. The findings show that participants considered AI to be an effective tool for lesson planning, preparing teaching resources, visualization, increasing student participation, and supporting the learning process. However, they are also aware of limitations such as the potential unreliability of AI, its capacity to generate misinformation, and the risk of restricting students' creative thinking. These results highlight the importance of planned, conscious use of AI as a pedagogical tool. Future studies could build on these findings and explore their various aspects more thoroughly in depth. Firstly, the selection of participants in future research may be broader, including a wider range of pre-service teachers, disciplines, and educational institutions. This would increase the transferability of the findings and reveal how AI is perceived in different contexts. For instance, examining differences in AI use across disciplines such as science, mathematics, the social sciences, and language education could illuminate subject-specific pedagogical practices. The effectiveness of teacher training programs related to AI could also be investigated. The findings suggest that pre-service teachers require training in new AI-related skills, such as prompt writing, content verification, and pedagogical adaptation. Future research could therefore evaluate how AI training develops pre-service teachers' technological proficiency, pedagogical approaches, and creative thinking skills. Furthermore, research could examine how teachers apply ethical decision-making and critical evaluation processes when using AI tools. Additionally, although pre-service teachers are concerned about the accuracy of information when using AI, they still tend to use it without verifying it. In this context, there is a need for studies that connect technology, AI, and epistemology. While this study presents important findings regarding pre-service teachers' use of AI, future studies might focus on increasing participant diversity, ensuring methodological diversity, evaluating teacher education programs, and detailing classroom pedagogical practices. This will reveal the potential of AI as a pedagogical tool in education more comprehensively and reliably.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

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