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A new era in early childhood education (ECE): Teachers' opinions on the application of artificial intelligence

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Abstract

This study aimed to evaluate the role of AI in preschool from the perspective of preschool teachers. The research group consisted of 101 preschool teachers. The study group was selected according to the easily accessible case sampling method, one of the purposeful sampling methods. The study was a phenomenology, which is a qualitative research design. Qualitative data were collected using a semi-structured interview form. Data were analyzed using inductive content analysis. As a result of the analyses, the participants stated they did not feel sufficient regarding Al literacy and competencies. The participants also emphasized that using AI in preschool was appropriate and would improve children's skills, such as AI literacy and computational thinking. Moreover, they stated that using AI in preschool would cause privacy and security concerns for different reasons, such as not protecting personal data, using children's pictures, and providing false and misleading information. The participants stated that they were worried about the implementation process of Al due to lack of content knowledge, lack of infrastructure, physical structure of the classroom, and lack of materials. In addition, participants emphasized that if the existing concerns were eliminated, AI could be easily integrated into the preschool period. In addition, it was determined that most participants had problems in modeling and drawing a model related to AI.

Keywords Artificial intelligence · Early childhood education · Preschool teachers

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1 Introduction

Technological advancements have revolutionized various aspects of our lives, and education is no exception (Tatlı & Özen, 2023). These changes have significantly influenced countries' educational perspectives (Yoo & Yi, 2022). Education has dramatically transformed, seamlessly integrating technology into teaching and learning activities (Yıldırım, 2023). This transformation in educational paradigms sets the stage for our study, which explores the role of AI in early childhood education from the perspective of preschool teachers.

Technology integration into educational environments has enriched the learning environments (Lu et al., 2022). Therefore, countries have utilized various technological advancements such as augmented reality, virtual reality, and flipped learning to enrich their educational processes. One of the areas used to enrich the educational process is Al. Al plays a vital role in enhancing students' learning experiences, as Prentzas (2013) highlighted. Therefore, the importance of AI in the educational process is increasingly recognized. For example, projects have been initiated in the United States, China, Canada, and South Korea to integrate AI into the school curriculum (Asia Pacific Foundation of Canada Korea Al Ethics Association, 2021; Chiu & Chai, 2020). Integrating AI into school curricula occurs in two forms: learning about AI and learning with AI (Lim, 2024). Learning about AI involves understanding fundamental AI concepts and content while learning with AI refers to the use of AI as a tool for learning (Zhang & Aslan, 2021). The aim of integrating AI into school curriculums by countries is to ensure students become AI literate. Therefore, students need to be equipped with AI knowledge, AI skills, and AI attitudes to become AI literate (Long & Megerko, 2020). AI should be integrated into the educational process to increase the number of literate individuals.

For individuals to become AI literate, it is essential to provide basic knowledge and skills related to Al starting from early childhood education. Early childhood has unique characteristics that allow children to develop the skills needed for daily life, acquire knowledge through play, and gain the foundational skills necessary for future grade levels (Li & Chen, 2023). However, there is not enough research on Al in Preschool (Samara & Kotsis, 2024). Research on integrating AI in preschool education shows that AI is beneficial and useful for children's development (Chen & Lin, 2024). It is crucial for children to acquire fundamental knowledge and skills related to AI from an early age to ensure a solid foundation in this field. There are many benefits for children who learn Al from an early age. For example, using AI practices in preschool contributes to developing children's knowledge of AI (Williams et al., 2019). Because it may be difficult to acquire basic knowledge and skills that were not learned at an early age and a later age (Karademir & Yıldırım, 2021), children should have the necessary qualifications for potential careers and new professions related to Al that will arise in the future (Wamba et al., 2022). Because children begin to decide from an early age which fields they excel in and which professions they will work in later years (Yıldırım, 2021; Karademir & Yıldırım, 2021). Children's interest in AI should also be

encouraged from an early age. For example, Allen (2016) emphasizes that half of children lose interest in many fields by the end of secondary school.

Therefore, early on, providing children with information about Al can foster their interest in AI. Additionally, implementing AI activities from preschool onwards contributes to developing children's computational thinking and problem-solving skills (Fauzi et al., 2023; Williams et al., 2019). AI in preschool can enable customized learning opportunities tailored to children's needs (Devi et al., 2022). The use of Al robots in the preschool period contributes to developing children's literacy skills (Kewalramani et al., 2021). Therefore, children should be exposed to AI-related applications early (Touretzky et al., 2019). While there are many significant benefits to using AI from EC, implementing AI programs in EC is a new topic (Su & Yang, 2022). There are also challenges in implementing AI in preschool settings. Although AI is integrated into preschool education, children's awareness and knowledge of AI may not be at the desired level (Lin et al., 2020). Additionally, determining the basic AI concepts to be taught in preschool and how to teach these concepts to children effectively presents another challenge (Yang, 2022). Furthermore, constant supervision of AI systems by a teacher or parent in preschool is crucial for ensuring privacy and security. This issue represents one of the critical challenges in implementing AI in preschool (Luo et al., 2024). Zhang and Aslan (2021) emphasized that using AI in preschool may not be suitable for children's development. Moreover, Studies related to AI generally focus on middle and high school periods (e.g., Sabuncuoğlu, 2020). However, AI studies in early childhood emerge as a potential area in education.

In the preschool period, AI can be introduced to children in various ways, and fundamental knowledge about Al can be taught to them. Learning through play and teaching with Al robots and kits can be implemented during preschool. Learning occurs as students interact with AI tools (Vartiainen et al., 2020). Children in preschool can learn basic AI information by interacting with Al robots and kits (Hamdan et al., 2017; Nan, 2020; Vartiainen et al., 2020). Additionally, AI can be both an essential opportunity for cognitive development in preschool children and a potential threat to them (World Economic Forum [WEF], 2022).

Children often lack the resources to respond to biased events or correct misinterpretations of data (WEF, 2022). Furthermore, young children may struggle to learn and explore AI information (Su et al., 2022). However, challenges also arise from AI program design and the insufficient provision of AI programs in early AI education studies (Durrani et al., 2024; Su, 2024b). Another difficulty is the lack of clear guidelines for teachers on using AI in preschool (Çelik et al., 2022). This situation contributes to teachers' negative attitudes and low self-confidence (Su et al., 2023; Su, 2024a). Therefore, well-designed AI tools in the preschool period can facilitate the development of children's AI-related knowledge and skills. Hence, well-designed programs, robots, and kits are needed (Williams, 2018; Williams et al., 2019). Indeed, the use of educational robots in the learning process can contribute to enriching educational environments. Educational robots are, therefore, effective learning tools for students and supportive instruments for teachers (Lee et al., 2010; Yun et al., 2024). Moreover, numerous studies demonstrate the effectiveness of educational robots (e.g., Yun et al., 2011). Consequently, developing AI-supported educational robots will enhance their functionality and usage in

early childhood education (Akdeniz & Özdinç, 2021). Furthermore, using AI tools effectively develops children's language and literacy skills (Neumann, 2020). On the other hand, when AI-supported robots are used in early childhood education under specific guidelines, children can interact with these robots effectively (Yi et al., 2024). Additionally, integrating AI robots with games facilitates learning mathematical concepts (Vrochidou et al., 2018). Therefore, it can be stated that using well-designed AI tools, integrated with diverse methods and techniques, yields effective results in early childhood education. For example, PlushPal has been used in EC to help young children understand the concepts of Al or machine learning more easily (Tseng et al., 2021). However, many Al devices are emerging in children's lives, such as voice-activated personal assistants, home robots, and internet-connected intelligent toys (Williams, 2018). In short, while bringing artificial intelligence tools or platforms into EC classrooms and demonstrating their positive effects (e.g., Su & Yang, 2022; Vartiainen et al., 2020), teachers need to have sufficient expertise in Al for its use in the EC period (Luckin et al., 2022). At this point, it would be appropriate to provide examples of using AI tools in early childhood. This is because using AI robots in preschool settings yields positive outcomes for children (Yin et al., 2024). In this context, various AI robots, such as NAO, KASPAR, AIBO, and RuBI, are used in early childhood education. For instance, AIBO, developed by Sony, enhances children's motivation during the learning process and provides an engaging learning experience. RuBI, designed for human interaction, is utilized in preschool education to support children in developing social communication skills (Johnson et al., 2012).

In the preschool period, teachers are responsible for the learning related to AI (Çelik, 2023). Teachers play an active role in students' development as AI-literate individuals (Casal-Otero et al., 2023). Therefore, teachers' qualified professional development in AI has been effective in helping students achieve the desired level of academic success in AI. For instance, Hibpshman (2007) stated that teachers' competencies in a field are directly proportional to students' achievements. In this context, teachers' competencies in the field of AI are directly proportional to students' achievement of the desired competencies in AI. Therefore, teachers need sufficient knowledge and skills to teach AI effectively (Cavalcanti et al., 2021). However, the literature shows that teachers lack knowledge about AI (Sanusi et al., 2022). Indeed, it is emphasized that preschool teachers do not have sufficient knowledge and skills in AI (Su & Zhong, 2022). For example, studies have been initiated in Hong Kong to increase the professional development of preschool teachers on AI (Yang, 2022).

For teachers to incorporate Al into their classrooms, age-appropriate and necessary materials and resources related to AI need to be developed (Laato et al., 2020). Indeed, the literature highlights the limited availability of lesson plans, AI program units, and resources related to AI that teachers can use in their classrooms (Chiu & Chai, 2020; Lindner & Romeike, 2019). For example, Chiu et al. (2021) emphasized in their study that teachers need AI program units for classroom practices. Similarly, Yang (2022) underlined the necessity of developing activities and teacher guides related to AI. The lack of sufficient resources and teachers' limited knowledge of AI are significant barriers preventing them from integrating AI into their classrooms (Yıldırım & Akçan, 2024). Moreover, even when teachers possess adequate

knowledge in a specific area, insufficient resources create obstacles to implementing classroom practices. Additionally, most existing AI-related resources are designed for computer science educators, while there is a lack of adequate materials, teacher guides, student activity resources, and user manuals tailored for preschool education (Kim et al., 2021; Yang, 2022). Therefore, developing resources for preschool teachers while organizing professional development programs is crucial. In this context, efforts should focus on creating teacher guidebooks, student activity kits, and programs to teach basic AI concepts and skills specifically for preschool teachers. Hence, preschool educators must receive early education on AI (Su & Zhong, 2022). Professional development training on AI plays a central role in encouraging teachers and enabling them to implement AI-related practices in their classrooms (Ding et al., 2024). Teachers who receive AI training will not only enhance their literacy in the field but also effectively incorporate AI into their classrooms (Yıldırım & Akçan, 2024). However, the lack of AI materials in preschool education remains one of the major challenges in developing teachers' AI literacy. If preschool teachers do not receive sufficient training in this field, they will not feel confident implementing AI in their classrooms and may exhibit negative attitudes (Su et al., 2023). This situation can lead to low performance among preschool teachers (Park et al., 2023). Preschool teachers need sufficient knowledge and skills to demonstrate high performance related to AI (Chounta et al., 2022). Preschool teachers' lack of mastery of the subject they will teach will directly affect their self-efficacy (Stohlman et al., 2012) and lead to ineffective teaching (Çelik, 2023). Moreover, this situation will lead early childhood teachers to have negative attitudes towards AI (Su et al., 2023). Therefore, qualified AI professional development programs must be established for teachers to implement AI in classrooms (Park et al., 2023).

When the literature is examined, although there is not enough research on AI in ECE compared to middle and high school levels (Su et al., 2022), the number of AI studies in ECE has been increasing in recent years (Kewalramani et al., 2021; Williams et al., 2019). These studies specifically point to using robots and kits to teach basic AI concepts to children in EC (Williams et al., 2019). Moreover, there are limited studies on developing children's AI literacy in preschool (Durrani et al., 2024). However, there needs to be more professional development programs that aim to show how preschool teachers can incorporate AI into their classrooms and improve their professional skills. Furthermore, there is insufficient research on the ideal nature of AI programs in ECE (Williams et al., 2019). In addition, preschool teachers' busy schedules make it challenging to participate in professional development programs related to AI (Su et al., 2023). Moreover, preschool teachers' readiness for AI education and ability to develop appropriate AI materials and activities are crucial. Therefore, AI training programs designed for early childhood teachers should be tailored to their specific needs to facilitate the integration of AI into the educational process. Moreover, when examining the literature, studies addressing the challenges, opportunities (Su et al., 2023), reviews (Su & Yang, 2022), program design, and future directions for the use of AI in early childhood education can be found (Su & Zhong, 2022). Much existing research also focuses on teaching and learning with AI tools and AI literacy in early childhood education (e.g., Williams et al., 2019). However, few studies explore teachers' perceptions of AI literacy in

preschools (Su, 2024a, 2024b). In this context, this study aims to present detailed insights into preschool teachers' views on AI. Furthermore, by combining teachers' perspectives with existing literature on early childhood education and AI, it seeks to provide a foundation for future research on the use of AI in preschool education. Another goal of this study is to propose recommendations for future research based on teachers' perspectives.

1.1 Gaps in the field

Examining teachers' perspectives on artificial intelligence is essential for understanding how AI is integrated into teaching and learning processes. Teachers' perceptions of AI as a leading technological advancement will play a critical role in its adoption in the classroom. Moreover, the growing use of AI in education has facilitated the integration of emerging technologies into educational settings. Therefore, the Technology Acceptance Model (TAM) has been considered in integrating new technological advancements. This model explains individuals' processes of accepting and adopting new technologies (Davis, 1989). This model suggests that perceived usefulness and perceived ease of use are fundamental determinants of users' attitudes toward technology, which, in turn, influence their intention to adopt it (Davis, 1989; Özkaynar, 2024). Therefore, teachers' inclination toward using artificial intelligence is influenced by its benefits and ease of use. Providing training in this area will impact preschool teachers' adoption of AI and play a critical role in their acceptance of this technology. In this model, the perceived usefulness of new technologies is a crucial factor. During this process, preschool teachers' perceptions of the usefulness of artificial intelligence may vary depending on its contributions to children's development. In this model, the perceived usefulness of new technologies is a key factor. During this process, preschool teachers' perceptions of the usefulness of artificial intelligence may vary depending on its contributions to children's development. Furthermore, privacy, security, and ethical concerns arising while adopting new technology directly influence teachers' use of these tools. Investigating whether ethical concerns affect the relationship between perceived benefits, attitudes, and intentions in the context of artificial intelligence adoption is important for the relevant literature (Özkaynar, 2024). Indeed, numerous studies emphasize privacy, security, and ethical issues surrounding artificial intelligence (Hine & Floridi, 2022).

This model emphasizes the importance of examining these factors. Therefore, for artificial intelligence to be accepted, teachers' perspectives on these issues should be explored, and programs should be designed. Another key aspect this model highlights is the ease of use of new technologies (Davis, 1989). The ease of use of new technology is emphasized as a key factor directly affecting its adoption. Therefore, it is essential to develop support systems, professional development programs, classroom examples, and other resources that facilitate teachers' use of artificial intelligence tools (Alshorman, 2024). Consequently, these two dimensions in the Technology Acceptance Model (TAM) assess individuals' perceptions regarding adopting new technologies (Koul & Eydgahi, 2017). In other words, this model focuses on understanding why people accept new technologies and why they do not (Granic

& Marangunic, 2015). Another important factor emphasized in the TAM is external factors, such as infrastructure, privacy, and security, that are associated with the new technology being implemented. The model highlights that if these factors are inadequate, individuals' training regarding the new technology will not be as effective as intended (Abou Kamar et al., 2024). Indeed, issues such as data security, privacy, and confidentiality are significant in teachers' integration of artificial intelligence into teaching and learning processes (Hargis, 2014). At this point, utilizing the TAM to explore teachers' perspectives on these issues is essential for integrating new technologies. In TAM, the perceived usefulness and ease of accessibility of new technologies facilitate their integration (Urbani et al., 2024). At this point, increasing awareness of the perceived usefulness, ease of use, support for new technologies, accessibility, and issues related to privacy and security concerning artificial intelligence for preschool teachers will contribute to facilitating the integration of AI in early childhood education. Therefore, this study explores how preschool teachers perceive artificial intelligence, its effects on students, and their concerns regarding privacy, security, and ethical issues related to AI. A literature review reveals that integrating artificial intelligence into the educational process is less prevalent in middle and high schools compared to early childhood education and is insufficient (Kewalramani et al., 2021; Su et al., 2022).

On the other hand, studies emphasize that using artificial intelligence in early childhood education significantly impacts children's various skills (Williams et al., 2019; Fauzi et al., 2023; Yıldırım & Akcan, 2024). However, there is a lack of sufficient research exploring preschool teachers' perspectives on artificial intelligence as a new technology (Su, 2024a, 2024b). In this context, when examining preschool teachers' views on artificial intelligence, it is crucial to consider factors such as perceived benefits, ease of use, privacy, and security within the framework of the TAM, as these factors are essential for the integration of AI in early childhood education (Scherer et al., 2019). Therefore, the absence of studies in the literature addressing preschool teachers' perspectives on the ease of use of artificial intelligence aims to fill a gap in the existing body of research. Moreover, issues such as ethical concerns, data privacy, and biases related to using artificial intelligence in early childhood education have not been adequately explored (e.g., Luo et al., 2024). It is crucial to thoroughly examine these issues in early childhood education, as understanding how teachers perceive them is vital. It is important to investigate preschool teachers' perspectives to gain deeper insights. Additionally, the success of AI education at the preschool level is mainly dependent on teachers' knowledge, skills, and attitudes toward AI (Yıldırım & Akçan, 2024; Su et al., 2023). This article aims to present preschool teachers' perspectives on the use of artificial intelligence in early childhood education and offer practical recommendations for developing programs, guidelines, and materials to enhance teachers' professional development about AI (Chiu & Chai, 2020; Chounta et al., 2022; Kim et al., 2021; Lindner & Romeike, 2019; Yang, 2022). In conclusion, considering teachers' perspectives is essential for effectively addressing AI in early childhood education and filling the gaps in existing literature. This aligns with considering the necessary conditions for integrating new technologies, as emphasized by the TAM. Furthermore, this study examines how AI can be integrated into early childhood education by addressing key issues

such as effectiveness, ethics, privacy, and security. Consequently, this study will significantly contribute practically and theoretically to future research.

In this context, no study detailing teachers' views on using AI in ECE was found when the literature was analyzed. In addition, in this study, the concerns experienced by teachers in the process of integration of artificial intelligence into ECE, teachers' AI competencies, teachers' AI literacy, teachers' AI modeling, and the measures to be taken for the integration of ECE in the age of AI were determined. For this reason, this research aims to evaluate the role of AI in ECE from the perspective of preschool teachers. Because preschool education is the first place, individuals gain the skills and knowledge they need to acquire later. There are difficulties in gaining the skills and knowledge that are not acquired in this period in later ages. At this point, the preschool period has an important effect on acquiring skills and knowledge related to Al from an early age. In acquiring Al literacy in preschool, preschool teachers' views on Al are important. This study explores teachers' views on learning activities suitable for AI, the use of AI in preschool, the challenges encountered, opportunities, ethical issues, teacher qualifications, AI competence, AI literacy, and concerns about privacy and security when using AI. Addressing these issues from the teachers' perspective and including AI applications in preschool is essential. Additionally, this study serves as a foundation for future research. Therefore, the research question of this study was, *"How do preschool teachers' views on artificial intelligence applications in ECE?"*.

2 Literature review

2.1 Al in ECE

Al has started to be used rapidly in various fields. The rapid use of Al has affected people's lives in all areas (Zhang & Aslan, 2021). AI development makes integrating and using AI in education important (Çelik, 2023). The impact of Al on people's lives has led to the reshaping of teaching and learning practices used in the education process (Alwaqdani, 2024). AI in education provides students with unique experiences and improves their learning (Prentzas, 2013). Therefore, individuals in the digital world need to learn basic knowledge about AI (Park et al., 2023). Being AI literate is essential for everyone to learn basic knowledge about AI (Ng et al., 2021). The importance of AI literacy has led countries to work in this field. For example, the Chinese and American governments have initiated projects to integrate AI into school curricula by 2028 (Chiu & Chai, 2020). The US has implemented different projects related to AI through the National Science Foundation (NSF) (Zhang & Aslan, 2021), and AI4K12 has published an AI curriculum guide (Ouyang & Jiao, 2021). Similarly, Canada and South Korea are also working to make K-12 students AI literate (Asia Pacific Foundation of Canada Korea AI Ethics Association, 2021). On the other hand, limited studies exist on developing children's AI literacy (Durrani et al., 2024). Therefore, the preschool level can be an appropriate starting point for learning AI literacy (Su, 2024a, 2024b). In this context, studies on AI have been conducted and continue to be undertaken. While most of the studies on AI focus on

middle and high schools, it is known that there are fewer studies in the preschool period (Payne, 2019; Su & Zhong, 2022; Van Brummelen et al., 2021). Therefore, it is vital to integrate AI into the preschool period (Yi et al., 2024).

Although studies related to Al in the preschool period may not be at the desired level (Su et al., 2023), it is vital to instill AI literacy early for children's development (Kewalramani et al., 2021). Additionally, incorporating AI early on is a step toward future success for children in high school and higher education (Gammage, 2006). In other words, it ensures the acquisition of fundamental concepts and skills related to AI that children will encounter in the future. Furthermore, using AI in the preschool period will be crucial in acquiring different skills, such as computational thinking, coding, and algorithmic thinking (Druga et al., 2019; Lin et al., 2020; Nan, 2020; Williams et al., 2019). Therefore, AI should be integrated into the education process from preschool onwards. Different teaching–learning processes and materials can be used to incorporate AI into preschool education programs (Druga & Ko, 2021). Typically, in the preschool period, AI is provided through AI-powered robots (Lin et al., 2020). Children interact with robots in the digital age and engage in easier learning processes. For example, Williams et al. (2019) designed an AI-powered robot interface for children to explore AI-related knowledge and skills. On the other hand, because of the many benefits of using AI from early childhood, various countries have begun developing AI policy frameworks to integrate AI into the education process, particularly in preschool education. AI technology policy is essential to guide its applications in the right direction, helping governments steer AI as intended (Yang & Huang, 2022). For example, China developed the 'New-Generation Artificial Intelligence Development Plan' to ensure the effective implementation of AI and achieve desired outcomes (The State Council of the People's Republic of China, 2017). Similarly, NSF and other research institutions are conducting policy studies to integrate AI into preschool education and develop best practices (Yin et al., 2024). Likewise, ISTE (2008) has prepared resources and guides for educators to integrate AI into the educational process. These guides aim to support teachers' professional development and ensure the effective use of AI in classrooms. In creating these guidelines, policies are used to leverage digital tools like artificial intelligence to achieve national goals (Filgueiras & Almeida, 2021). The design of educational policies involves well-defined objectives in AI, curriculum development, the adoption of appropriate technologies, and the establishment of necessary infrastructures for implementation in schools (Filgueiras, 2024). In this context, a policy guide on AI for children has been developed, emphasizing how AI can be used in early childhood education and the critical considerations to remember (Penagos et al., 2020). Moreover, many policies and practical applications utilize AI robots and tools as instruments in teaching and learning processes. This enables the functional use of AI-supported educational robots in preschool settings (Akdeniz & Özdinç, 2021). Therefore, through policies in early childhood education, AI robots are employed to support children's socialization, learning of mathematical concepts, and acquisition of language skills.

This study used the TAM to examine preschool teachers' perspectives on integrating AI into early childhood education. TAM is a theoretical framework for understanding how individuals adopt new technologies. It emphasizes perceived

usefulness and ease of use as key acceptance determinants. In this study, TAM guided the formulation of research questions, the development of the data collection instruments, and the interpretation of the findings. Existing literature suggests that teachers often lack sufficient knowledge about AI, which poses a significant barrier to its integration into early childhood education (e.g., Lin et al., 2020; Su et al., 2022). According to TAM, when educators perceive AI as valuable and user-friendly, they are more inclined to incorporate it into their teaching practices. Conversely, if AI is complex or challenging, they may be inhibited from adopting the technology (Urbani et al., 2024). Interview protocols were designed based on TAM constructs to examine these aspects, focusing on teachers' attitudes toward AI adoption, perceived benefits, and potential barriers.

Policy and training programs are needed for AI to be used in preschool. In many studies, the development of policies and training programs related to AI will facilitate the implementation of AI (Yıldırım & Akcan, 2024). However, the lack of adequate policies and training programs related to AI may cause preschool teachers to experience uncertainties about implementing AI and show resistance towards AI. Therefore, it is necessary to consider external factors such as perceived usefulness, ease of use, policy support, privacy, security, and ethics that affect the integration of a new technology mentioned in the TAM model. Accordingly, future studies need to reveal preschool teachers' views within the scope of the principles emphasized in the TAM model. Based on the TAM theoretical framework, this study systematically analyzes preschool teachers' perspectives on AI, including concerns about privacy, security, ethics, policy frameworks, curriculum integration, and teacher competencies. Adhering to TAM principles, this research aims to provide valuable insights into the factors influencing AI adoption in preschool education and to identify the necessary conditions for practical and sustainable implementation.

2.2 Ethical implications of AI in education

While integrating artificial intelligence (AI) into education brings many benefits, it has also raised user concerns. Ethical concerns have drawn the attention of countries, organizations, and academics, prompting studies on the relationship between humans and technology (Huang, 2023). Privacy is at the forefront of these studies, as AI involves the collection of vast amounts of data. Misusing collected data can lead to data breaches and algorithmic bias, resulting in discrimination, injustice, and unethical use of technology (Akgün & Greenhow, 2022). Moreover, creating biased algorithmic structures in AI could expose certain student groups to unfair treatment (WEF, 2022). Therefore, integrating AI into education must prioritize respecting, protecting, and promoting human rights, fundamental freedoms, and dignity (UNESCO, 2022). In response, countries have developed and continue to develop general laws concerning AI (Hine & Floridi, 2022). These laws emphasize human oversight, safety, privacy, transparency, and non-discrimination (European Parliament [EP], 2023). The main objective of these laws is to establish a rational foundation for the classroom use of AI (Tang & Su, 2024). Furthermore, studies highlight that focusing on factors

like transparency, accountability, respect for personal rights, user control over data, and eliminating bias and discrimination during AI implementation can prevent such ethical issues (Leta, 2023).

2.3 Preschool teachers in AI teaching

The role of teachers is vital for implementing Al to educationally meaningful learning and obtaining the desired results (Lim, 2024). Teachers are primarily responsible for education (Yıldırım, 2023). On the other hand, teachers also act as mediators between the school's AI policies and student needs (Felix, 2020). To use Al in education, teachers should have sufficient knowledge and skills about Al (Chounta et al., 2022; Kuleto et al., 2022). Therefore, teachers are the persons who will ensure the use of Al in the teaching–learning process (Luckin et al., 2022). The critical role of teachers in the education process clearly shows the vital role of teachers in implementing AI in classrooms (Çelik, 2023). Effective learning depends on teachers' classroom pedagogical methods (Prieto et al., 2018). This situation will also play a role in the pedagogically meaningful and effective teaching of Al in the school. Similarly, in preschool, educators must know how to use Al technologies (Su & Zhong, 2022). Many studies emphasized that teachers should have sufficient knowledge and expertise in AI to incorporate AI into their classrooms (e.g., Nazaretsky et al., 2022). However, it is emphasized that preschool teachers do not have sufficient knowledge of AI (Su et al., 2023). Also, there is a lack of training and practical experience in AI for ECE teachers, and AI integration into the preschool curriculum is rarely known (Yang et al., 2024).

Preschool teachers' lack of sufficient knowledge about AI may cause children to have problems acquiring the essential knowledge and skills they need to learn about AI (Su & Zhong, 2022) because teachers' knowledge and skills in a field are directly proportional to students' academic success (Yıldırım, 2023). Similarly, teachers' perceptions and beliefs about Al affect their classroom practices. This situation also affects teachers' interactions with children (Avidov-Ungar et al., 2020). Moreover, it affects teachers' self-efficacy and attitudes (Arslan & Yıldırım, 2020). Because teachers' self-efficacy and attitudes affect their classroom activities (Yada et al., 2022). Therefore, preschool teachers need to have sufficient knowledge and skills about AI to teach AI effectively in their classrooms (Su et al., 2022). Many studies present practices that show that preschool teachers can do age-appropriate activities (Ng et al., 2021; Su & Yang, 2022). However, these practices are not at a sufficient level. Therefore, there is a need for pedagogical solid training specially designed for AI for teachers to have enough knowledge and equipment about AI (Çelik, 2023; Sanusi et al., 2022). On the other hand, the Al programs and development studies required for implementing Al applications in preschool are insufficient (Yang, 2022). In addition, the lack of teacher guides required for preschool teachers to implement AI in their classrooms prevents the implementation of AI in preschool (Durrani et al., 2024).

3 Method

3.1 Research design

The research was designed according to phenomenology, one of the qualitative research method designs, to objectively, validly, and reliably reveal the effects of artificial intelligence on early childhood education. Phenomenology is preferred to obtain detailed information from individuals with past experiences with the phenomenon or event in focus (Yin, 2017). In phenomenological studies, individuals with expertise in a particular phenomenon are also needed (Rubin & Babbie, 2016). For this reason, it would be appropriate to include participants interested in this subject when applying their views on implementing artificial intelligence applications in the preschool period. Moreover, phenomenological samples are usually selected from a group with a particular characteristic (Strauss & Corbin, 2014). This study included the views of preschool teachers interested in artificial intelligence due to the nature of the phenomenological design. Phenomenology focuses on situations we know but lack a detailed and profound understanding of (Tekindal & Uğuz Arsu, 2020). In this context, it provides a suitable research framework for uncovering the reflections of artificial intelligence on humans. Furthermore, the phenomenological approach aims to reveal participants' shared experiences within the studied group (Creswell, 2020). In this approach, participants reflect on their own experiences. Therefore, phenomenological studies are purpose-driven, and researchers strive to understand the participants' experiences deeply (Baker et al., 1992). In this context, the study aimed to examine teachers' views on the impact of artificial intelligence on early childhood education and to provide a comprehensive interpretation.

3.2 Participants

Participants were selected using purposive convenience sampling, a non-probability sampling method. Convenience sampling facilitates the researcher's time and effort in selecting individuals to participate in the study (Balcı, 2016). Within the scope of the study, while revealing teachers' views on Al applications in the preschool period, the views of teachers who voluntarily participated were included. This led to the selection of the easily accessible sampling method from the purposeful sampling methods of the study. In phenomenological studies, individuals with interest and experience in a particular phenomenon are also needed (Rubin & Babbie, 2016). This was effective in the preference of convenience sampling, which is one of the purpose-oriented sampling methods of the study. On the other hand, the representation of the sample in qualitative research is related to reproducibility and credibility (Creswell, 2013). This study determines a sample that is thought to represent the best diversity related to the subject (Neuman & Robson, 2014). On the other hand, the primary concern in qualitative research is to examine the diversities, richness, differences, and contradictions possible in the universe (Şahan & Uyangör, 2021). In this context, the following criteria were used to form the study group:

(1) Being an active preschool teacher.
(2) Having at least three years of experience.
(3) Having received training or awareness about AI.
(4) Being willing to implement AI applications in classrooms.
(5) Voluntarily participating in the interviews.

Individuals who met these criteria and were actively teaching were included in the study group. These criteria were established because having insights into AI is vital for phenomenological studies. Accordingly, the study group comprised 101 preschool teachers (14 male, 87 female). The early childhood teachers participating in the study had varying levels of experience (1–10 years: 60 teachers; 11–20 years: 35 teachers; 21 years and above: 6 teachers). Additionally, 86 participating teachers worked in public schools, while 15 worked in private institutions. Indeed, saturation is crucial in qualitative data. Saturation is the number of data collection procedures needed to gather relevant information in cases with limited knowledge about a new study (Namey et al., 2016). Langford et al. (2002) emphasized that data saturation in qualitative research should be at least 50. Moreover, when examples from the study group begin to repeat, and the codes and categories formed reach saturation, it can be stated that the study has achieved data saturation (Glaser & Strauss, 2017). Similarly, during interviews, when researchers start hearing similar comments, it is considered that the data has reached saturation, and the analysis of the collected data begins (Grady, 1998). On the other hand, the study group should be expanded until researchers fully understand the participants' perspectives (Saunders et al., 2018). Furthermore, researchers can include participants until sufficient data is obtained regarding the subject of the study (Kleiman, 2004). This is explained as data saturation in research. Therefore, a minimum sample size of 101 participants was used in this study. The study group comprised 101 preschool teachers because the responses from participants showed similarities and similar codes and categories were formed. In qualitative studies, there is no definitive number for achieving data saturation, placing significant responsibility on the researcher in this regard (Corbin & Strauss, 1990).

3.3 Data collection tools

3.3.1 Interview form

The study used a semi-structured interview to reveal preschool teachers' views on artificial intelligence. A literature review was utilized in the first stage of the artificial intelligence interview form developed for early childhood teachers. Then, a question pool was created. After the creation of the question pool, the interview form was evaluated by two different experts. One of the experts works in early childhood education, while the other specializes in artificial intelligence. Based on the feedback received from the experts, corrections were made to the interview form. "For example, the question 'Do you have any security and privacy concerns about AI' was revised to 'Do you have any security and privacy concerns about AI? Explain'

Another example is the question, 'What qualifications are required for teachers to use AI in the classroom' where the word 'Feature' was changed to 'Qualifications.' Based on expert feedback, the interview form was piloted with four preschool teachers to identify any unclear parts. After these pilot applications, the interview form was finalized. As a result of these steps, the interview form consisted of 8 questions (Ek-1). These eight questions, created within the study's scope, were designed to reveal teachers' views on the application of Al in the preschool period. Preschool teachers' views on AI are important when implementing Al in their classes.

3.3.2 Data analysis

The qualitative data obtained in the study were analyzed using the inductive content analysis method. The data were collected through interviews with preschool teachers. Accordingly, the analysis of the data was conducted in four stages: processing the data obtained from the interviews, coding the data, organizing the codes, and identifying and interpreting the findings (Yıldırım & Şimşek, 2011). Firstly, the qualitative data were coded separately by two different experts. One of the experts works in early childhood education, while the other specializes in artificial intelligence. The experts individually created themes, categories, and codes. Subsequently, the experts came together to determine areas of consensus and disagreement. They discussed the codes where there was disagreement. As a result of the discussions, consensus was reached on the codes. In this regard, the inter-coder reliability was calculated. The coding process for coding qualitative data is given in Fig. 1.

The qualitative data analyses were conducted using the process described above. The first researcher developed the themes and codes, while the second provided alternative organizational suggestions for this coding. In this context, themes and codes were created in alignment with the research problem. Some themes and codes were revised; for instance, 'privacy and security reasons' 'Recommendations to reduce security and privacy concerns,' and 'Recommendations for solutions to concerns' were changed to 'reasons,' 'recommendations to reduce concerns,' and 'solutions to concerns,' respectively. A similar revision process was applied to the codes. For example, the 'Science activities' code was updated to 'Science nature activities,' and the 'Lack of Curriculum' code was revised to 'Lack of AI Curriculum,' The following suggestions were made in case of disagreements during the coding process. Finally, a third expert, independent of the researchers, was consulted to review and edit the codes. For example, 'I do not feel enough/feel enough' and 'negative/positive' codes were used instead of 'yes/no'. This approach ensured that the themes and codes in the study were meaningful to the readers and enhanced the transparency and reliability of the inductive content analysis process.

3.3.3 Reliability and validity

Before the interviews were conducted, the teachers were informed about the interview process. After giving the information, the teachers were asked whether they would voluntarily participate in the interviews. The qualitative data from the teachers who voluntarily participated in the study were used. In this way, the

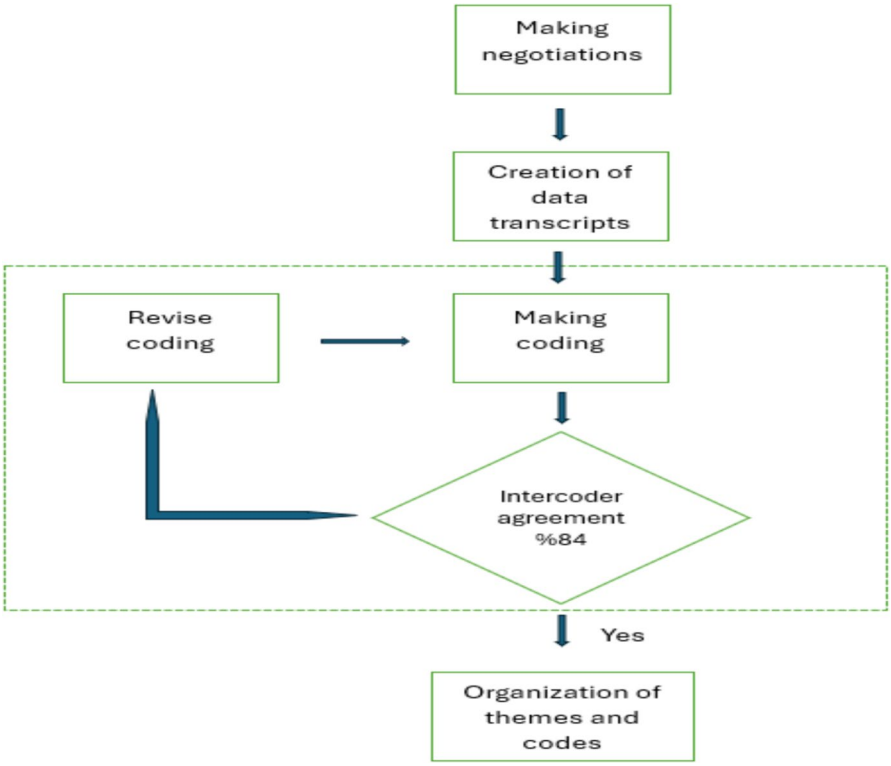

Fig. 1 Coding process

reliability of the qualitative data obtained was ensured, and ethical problems were prevented. In addition, two different experts took part in analyzing the interview form. The reason why two experts were involved in the study was to minimize the researcher bias and to ensure internal validity. For this reason, codes and themes were created by two experts. One of the experts works in early childhood education, while the other specializes in artificial intelligence. Codes were created in line with the opinions of the experts. Opinions were expressed on the codes that were not common, and the process was finalized. Inter-coder reliability was calculated, and the process was finalized. Inter-coder reliability was calculated as 84%. Inter-coder reliability is required to be at least 80% (Miles et al., 2014). In addition, inter-coder reliability can also be analyzed using different methods such as Cohen Kappa. In this reliability, 10% of the data are randomly selected. This study examined the reliability of the coding process of all data. Moreover, in qualitative studies, researchers may approach the process with bias or a directive perspective, which is one of the disadvantages of such studies. However, to focus directly on participants, researchers must "bracket" their personal opinions and biases (Groenewald, 2004). This prevents researchers from steering the process and enhances the validity and reliability of the study. Secondly, although

generalizations cannot be made in phenomenological studies due to the nature of qualitative research, insights can be gained by revealing individuals' experiences, emotions, and perspectives related to the research topic (Yıldırım & Şimşek, 2016). Therefore, even if generalization is impossible, direct quotations and findings from these studies can inform and contribute to future research.

3.3.4 Findings

Within the scope of the research problem, the following findings were obtained to address the gaps identified in the literature. The research question examined preschool teachers' competencies and literacy regarding artificial intelligence. Table 1 presents information about these examinations.

All participants emphasized that they felt inadequate regarding AI competence and literacy (Table 1).

The participants emphasized that they did not feel sufficient because they lacked knowledge of AI knowledge, AI application knowledge, AI tools, AI security, and privacy (Table 2).

Participants stated that Al can be used in various areas in early childhood, such as coding, science and nature, games, mathematics, language, and cognitive development activities (Table 3).

Participants stated that AI will develop skills such as AI literacy, creative thinking, computational thinking, and algorithmic thinking. These findings indicate that preschool teachers believe AI is beneficial and valuable for children (Table 4).

Most of the participants expressed that the use of AI in early childhood may lead to some issues regarding security and privacy. These findings show that teachers have concerns about offense and privacy related to using Al (Table 5).

Participants emphasized that artificial intelligence would cause privacy and security concerns, such as misusing information and photographs and violating private life (Table 6).

The participants made various suggestions to alleviate concerns about security and privacy issues arising from using AI in preschool settings. Participants stated that these concerns would be reduced if measures such as using AI under parental control, using it under teacher supervision, and avoiding entering personal data were taken (Table 7).

These findings reveal that most teachers consider using artificial intelligence appropriate in preschool (Table 8).

Many preschool teachers stated that they would like to receive training on AI, while some emphasized that they wanted to avoid receiving training on AI. The teachers' views on the qualifications they should have to integrate AI into their classrooms were also analyzed (Table 9).

Participants emphasized that teachers should have different characteristics to integrate AI into their classrooms. These findings cover the contents that should be included in AI issue development programs for preschool teachers (Table 10).

Participants stated they were concerned about various issues, such as a lack of information about AI, physical conditions, infrastructure, and materials. These

Table 1 Participants' views on AI competencies and literacy

Theme	Code	Sample views
AI competencies and literacy	I do not feel enough ($n=101$)	*"I believe it would be useful to receive training on AI applications." T43* *"Teachers should be open to development and equipped by the age requirements. They should learn new practices related to their profession." T9* *"They need to be open to innovation, and we need training to use technology. We need to learn how to integrate these trainings into our work." T13*
	Feel enough ($n=0$)	

Table 2 The reasons why teachers do not feel themselves adequate in Al competence and literacy

Theme	Code	Sample views
The reasons	Lack of Al knowledge ($n=60$)	*"I am unfamiliar with the program because I have not received training." T8*
	Lack of Al application knowledge ($n=24$)	*"I need to know the application of AI applications in education in the preschool period. "T37*
	Lack of knowledge of AI tools knowledge ($n=10$)	*"I need to know the AI tools used in the designed applications. Information on this subject should be provided." T36*
	Lack of privacy and security issues knowledge ($n=7$)	*"Many adults are concerned about security and confidentiality. It is important to get information on this issue. I think I am not knowledgeable about this issue." T44*

Table 3 Participants' views on the use of AI

Theme	Code	Sample views
The use of AI	Mathematics activities ($n=20$)	*"I think it can be effectively used in many areas such as mathematics and science." T37*
	Game activities ($n=19$)	*"Games can be created taking into account the developmental characteristics of children in the early childhood period." T40*
	Coding activities ($n=19$)	*"It can be used in coding lessons given from the early childhood period." T1*
	Science nature activities ($n=14$)	*"I think it can be used effectively, especially in science activities." T14*
	Language development activities ($n=11$)	*"Language activities can be used to support language development. In this way, different features such as effective speaking can be developed." T52*
	Cognitive development activities ($n=11$)	*"I think it will be used mostly to support cognitive development." T3*
	Story activities ($n=1$)	*"It can be used to create stories appropriate to the child's level" T40*
	Evaluation activities ($n=8$)	*"It can be used as an evaluation tool." T28*
	Art activities ($n=5$)	*"It can be used in visual art activities." T13*
	Al literacy activities ($n=5$)	*"It can be used for AI literacy to attract children's interest in this field." T11*
	Music activities ($n=6$)	*"It can be used in math, science, and music activities." T15*
	twenty-first century skill development activities ($n=5$)	*"It can be used to develop various skills such as problem-solving and social skills in children." T42*
	Animation activities ($n=5$)	*"It can be used in creating animations." T22*
	Drama Activities ($n=3$)	*"Drama activities can be designed to enable children to act out the pictures they draw." T72*
	Reading Activities ($n=2$)	*"Reading activities can be developed to improve preschool children's reading skills." T77*
	Portfolio file ($n=1$)	*"Portfolio file can be created to follow the development and interests of children." T86*

*Participants gave more than one answer

Table 4 Reflection of the use of Al on children's skill development

Theme	Code	Sample views
Al on children's skill development	Creative thinking ($n=16$)	*"Artificial intelligence fosters creative thinking." T42*
	Al literacy ($n=15$)	*"Al enhances children's skills such as AI literacy." T48*
	Communication skills ($n=15$)	*"It promotes the development of language skills, a cognitive skill." T55*
	Critical thinking ($n=14$)	*"It fosters critical thinking and algorithmic thinking skills." T41*
	Cognitive skills ($n=11$)	*"It contributes to the development of children's cognitive skills." T86*
	Computational thinking ($n=8$)	*"It facilitates the development of computational thinking skills." T44*
	Algorithmic thinking ($n=8$)	*"In the digital age, it enhances algorithmic thinking skills." T6*
	Problem-solving ($n=7$)	*"It aids in developing problem-solving skills." T50*
	Social skills ($n=6$)	*"It enhances social skills, a daily life skill." T4*
	Technology literacy ($n=5$)	*"It can enhance children's technological literacy." T23*
	Information and media literacy ($n=2$)	*"It can improve knowledge and media literacy skills." T14*
	Does not contribute to skill development ($\boldsymbol{n}=3$)	*"I do not believe children's skills can be properly developed." T19*
	Lack of development of social skills ($\boldsymbol{n}=1$)	*"While Al enables the development of creativity, there is a possibility of blunting social and human emotions." T84*

*Participants gave more than one answer

Table 5 Security and privacy concerns about AI

Theme	Code	Sample views
Security and privacy concerns about AI	Negative ($n=82$)	*"It can cause children's pictures to be used by bad people." T52*
		"There may be tools that can be used to lead children down the wrong path constantly. This worries us parents." T17
		"I have concerns that the data and images exchanged may be used for different purposes. I am not sure about privacy and security." T91
		"There will be information about children or education for a quality education. This will bring about these concerns." T30
	Positive ($n=15$)	*"I do not think that artificial intelligence programs applied in line with the class's needs would be dangerous for preschool level." T33*
		"I don't think it will be a privacy and security issue." T53
		"Since children will not use AI applications alone, I do not have any concerns about privacy and security." T87
	Do not know ($n=4$)	*"Since I don't know about artificial intelligence, I don't think it will cause anxiety." T31*

Table 6 The views of the participants about privacy and security reasons

Theme	Code	Sample views
The reasons	Misusing information ($n=32$)	*"The fact that the children's data and information are in digital environments worries me." T65* *"There may be security weaknesses in the personal data breach of children." T77*
	Misusing pictures ($n=25$)	*"Photographs of children falling into the hands of malicious people." T53* *"The applications that children will display should be kept to a minimum." T76*
	Inability to control ($n=9$)	*"Other people control artificial intelligence, and we cannot control it" T42*
	Misusing videos ($n=7$)	*I think your security videos could get into the wrong hands." T9*
	Misdirection ($n=6$)	*"Orientation with incorrect information" T25*
	Violation of private life ($n=5$)	*"Your private life may be violated." T62*
	Access unannounced (Camera, etc.) ($n=3$)	*"Not being able to control it worries me." T8*

*Participants gave more than one answer

Table 7 Recommendations to reduce security and privacy concerns related to AI

Theme	Code	Sample Views
Recommendations to reduce concerns	Use of parental control ($n=41$)	*"If parents supervise children, there will be no safety problem. Otherwise, it may not be suitable for safety." T5*
	Use of teacher supervision ($n=24$)	*"If used under the teacher's control, it will not create security and confidentiality problems. "*
	Avoiding entering personal data ($n=23$)	*"Personal information should not be entered as children's personal information may be leaked." T10*
	Not sharing photos of children ($n=14$)	*"Children's personal information (name, home address, phone number) should not be given to the app. T13*
	Data security ($n=7$)	*"Security measures should be increased; entering with a password can reduce this." T83*
	Access permission ($n=6$)	*"Access permissions of Al should be restricted" T96*
	Providing training to participants ($n=5$)	*"Users should be provided with sufficient information to use AI safely." T85*
	Use of avatars instead of pictures ($n=3$)	*"Safe internet use should be encouraged, and awareness should be raised through adult training." T16*
	Recommendations to policymakers ($n=3$)	*"It can be made safe with policymakers security measures." T92*
	Safety training ($n=2$)	*"Safety training for teachers and parents should be provided." T69*

*Participants gave more than one answer

Table 8 The views of the participants regarding the appropriateness of using AI in preschool education

Theme	Code	Sample Views
The appropriateness of using AI	Positive ($n=92$)	*"I think using AI in the preschool period would be useful. It can make the lessons fun." T14* *"Children should be exposed to AI from a young age because this is how children can adapt to technology." T26* *"Yes. Children's attention can be increased with robots or smart toys that will attract children's attention." T97*
	Negative ($n=7$)	*"I don't know much about it. However, maybe it can be used in time. I think it is not suitable for the age group now." T9*
	Partially appropriate ($n=2$)	*"I think it will be partially useful because it may not be fully appropriate for the children's level." T91*

Table 9 Views on receiving training on AI

Theme	Code	Sample views
Receiving training on AI	Positive ($n=97$)	*Keeping up with the times is important and necessary. T41* *"It is crucial to integrate AI into the preschool period so that children can gain experience with AI in later years. This is why teachers need to learn." T35* *"It will be useful for teachers to receive professional development as knowledge about accessing information and programming will facilitate teachers." T95*
	Negative ($n=4$)	*"I don't think AI can be used in preschool right now, so I do not need training." T63*

Table 10 Qualifications for teachers to use AI in the classroom

Theme	Code	Sample views
Qualifications for teachers	AI content knowledge ($n=34$)	*"Teachers need to be taught about AI." T37*
	AI practices knowledge ($n=26$)	*"Teachers need to know how and with which applications to use in preschool. T62* *"Teachers need to learn how to implement AI activities." T72*
	AI literacy ($n=23$)	*"It will be useful to learn AI and apply it in schools, so it is necessary to learn the developments and information about AI." T63*
	AI pedagogy knowledge ($n=18$)	*"If integrated correctly in the education process, the education-teaching process can be done with different education models in the classroom environment." T19*
	AI ethical knowledge ($n=12$)	*"Information about the ethical issues of artificial intelligence should be obtained in the preschool period." T3*
	AI skills knowledge ($n=10$)	*"Artificial intelligence can be effective in helping children acquire different skills. For this reason, it would be good to inform teachers about this issue. "T59*
	Technological literacy ($n=10$)	*"They should know different technological tools such as computers." T2*
	AI privacy and security knowledge ($n=10$)	*"It is important for teachers to know about privacy and security to implement AI." T100*
	Information and media literacy ($n=8$)	*"They should know computer technologies, information, and media literacy." T15*
	Interdisciplinary integration knowledge ($n=5$)	*Teachers should not always stick to a single field. Connections should be made not only with AI but also with other fields." T45* *"They need to learn how to integrate AI into lessons." T72*
	AI tools knowledge ($n=3$)	*"I think it would be beneficial if information is given about integrating artificial intelligence into education and its tools." T34*

*Participants gave more than one answer

Table 11 Concerns about the implementation of AI

Theme	Code	Sample views
Concerns about the implementation of AI	lack of Al content knowledge ($n=32$)	*"They should be given the necessary training about AI." T14*
	lack of physical conditions ($n=24$)	*"Since I work in a village school, my concern is that the classroom environment is unsuitable." T46*
	lack of infrastructure ($n=17$)	*"There should be hardware for implementing AI in the classroom." T6*
	safety and privacy concerns ($n=7$)	*"I have security and privacy concerns." T3*
	lack of materials ($n=11$)	*"Lack of materials needed to implement AI." T8*
	lack of expert support ($n=9$)	*"Not getting expert support when needed."T30*
	lack of knowledge in technology use ($n=8$)	*"Training should be provided to remove prejudices about learning new technological developments." T26*
	lack of Al ethical knowledge = 5)	*"Violation of ethical principles regarding AI and failure to protect privacy" T52*
	negative attitudes towards using AI ($n=3$)	*"Fear in the use of AI and being in an unfamiliar system" T13*
	lack of Al curriculum ($n=4$)	*"It should be integrated with the courses in which AI applications will be taught." T33*
	lack of peer support ($n=1$)	*"Not getting enough support from teachers" T9*

*Participants gave more than one answer

findings highlight the barriers to the effective implementation of AI in classrooms (Table 11).

Participants emphasized that they would be less concerned if they were informed about issues such as AI content training, lack of infrastructure, and information on AI ethics. These findings indicate preschool teachers' professional concerns about effectively using AI in their classrooms (Table 12).

4 Discussion

The first result of the research question examined the participants' views on AI competencies and AI literacy. The participants emphasized that they are insufficient regarding AI competencies and literacy. The participants emphasized that they did not feel sufficient because they lacked knowledge of AI knowledge, AI application knowledge, AI tools, AI security, and privacy. These findings are consistent with the results of this study and in line with studies showing that teachers' AI competencies and literacies need to be at the desired level (e.g., Kim & Kwon, 2023). Moreover, many studies emphasize that teachers should have the necessary competencies to teach AI concepts (Çelik, 2023; Kong & Abelson, 2022; Salas-Pilco et al., 2022). Teachers' competencies in AI also affect their AI literacy. AI literacy refers to understanding basic knowledge and concepts related to AI (Kandlhofer et al., 2016). Kitcharoen et al. (2024) reported that for teachers to teach AI effectively in their classrooms, it is necessary to develop their AI competencies, affecting AI literacy. Teachers with sufficient knowledge of this subject can include AI applications in their classes (U.S. Department of Education, 2023). Al professional development programs should be conducted to increase teachers' competencies in Al. There is a link between teachers' competencies in this field and the development of students' competencies. For this reason, policymakers in education should first ensure the development of teachers' competencies through teacher training. On the other hand, one of the factors influencing teachers' ability to implement classroom practices and AI literacy is the adequacy of AI-related resources (Yıldırım & Akcan, 2024). Therefore, while increasing teachers' knowledge of AI, attention should also be given to increasing the number of AI resources available in their classrooms.

The second result of the research question examined participants' views on the activities in which AI can be used in preschool. Participants stated that artificial intelligence can be used in different areas. Participants noted AI can be used in various activities such as coding, science-nature, game creation, mathematics, language, and cognitive development. On the other hand, these results show that teachers are aware that AI can be integrated into various activities and that these activities can be effectively utilized in classrooms. The literature reveals studies that align with the results of this study. Samara and Kotsis (2024) utilized AI to teach the concept of magnetism in preschool.

The third outcome of the research question showed that participants believed using artificial intelligence in early childhood would enhance children's various skills, such as AI literacy, creative thinking, computational thinking, algorithmic thinking, and technological literacy. However, some teachers expressed skepticism

Table 12 Recommendations for solutions to concerns

Theme	Code	Sample views
Solutions to the concerns	AI content training ($n=40$)	*"My lack of knowledge about AI is one of the reasons why I am worried. What I need is to eliminate my lack of knowledge about AI." T1*
	Lack of infrastructure ($n=21$)	*"Lack of adequate technological infrastructure and equipment should be prevented. "T55*
	Information on Al ethics ($n=10$)	*"Necessary measures should be taken regarding ethical violations in AI." T52*
	Training on security and privacy ($n=10$)	*"Training should be provided to address concerns about security and confidentiality." T3*
	Al curriculum should be prepared ($n=3$)	*"There should be a program for implementing AL in preschool." T49*
	Changing attitudes about Al ($n=3$)	*"Many teachers may think AI is difficult and give up using it. For this reason, their attitudes should be changed." T40*
	Al-appropriate content ($n=2$)	*"There should be appropriate content for using AI in preschool. "T61*

*Participants gave more than one answer

about whether using AI in early childhood would enhance students' skills. Nevertheless, it is noted that there are studies consistent with the findings of this research, underscoring that introducing AI in preschool allows children to develop a range of skills (e.g., Su & Yang, 2022; Touretzky et al., 2019). Additionally, incorporating AI activities from an early age improves children's computational thinking, problem-solving, and communication skills (Kandlhofer et al., 2016; Papadakis, 2021; Weintrop & Wilensky, 2015). Similarly, Kewalramani et al. (2021) maintain that AI usage enhances children's AI literacy, creative research, and collaboration. Su et al. (2023) also highlighted that introducing AI at a young age improves children's AI knowledge and literacy. Indeed, numerous studies underscore the importance of cultivating AI literacy in children (e.g., Steinbauer et al., 2021). However, while countries attempt to integrate AI into their curricula through curriculum development studies, it is also emphasized that incorporating AI into preschool may not be suitable for children's development (Zhang & Aslan, 2021). This result does not coincide with the results of the study.

The fourth outcome of the research question highlighted that participants emphasized teachers' need to know various areas such as AI content, AI application, AI literacy, and AI pedagogy. Indeed, studies emphasize the similarity of the characteristics required for teachers to implement AI in their classrooms with the findings of this study (Jamal, 2023; Nyaaba & Zhaı, 2024; Chiu & Chai, 2020). Teachers' roles are very important for implementing Al in classroom environments in an educationally meaningful way and achieving the desired results (Lim, 2024). For instance, Lindner and Romeike (2019) emphasized that teachers need to have knowledge of AI content, attitudes towards AI, AI skills, and AI ethics to integrate AI into their classrooms. Similarly, Lin et al. (2022) highlighted the necessity for teachers to have different attributes, such as AI content knowledge, AI application knowledge, AI ethics, and pedagogical knowledge. Also, Participants emphasized that artificial intelligence would cause privacy and security concerns, such as misusing information and photographs and violating private life. It can be stated that these privacy and security reasons emphasized by the participants align with the literature.

The fifth outcome of the research question indicates that participants expressed concerns that using AI in early childhood would lead to privacy and security issues. However, some participants stated there would be no privacy and security problems. Furthermore, participants have proposed various suggestions to alleviate concerns about the use of AI. They mentioned that if measures such as parental control, teacher supervision, avoiding the input of personal data, and not sharing children's photos are implemented, these concerns would decrease. In addition, the participants stated that policymakers must address privacy and security issues. They also noted that implementing security measures and training users on these issues will help reduce the problems. Considering all these results, it is evident that teachers are aware of certain concerns regarding the effective implementation of AI in classrooms, as well as potential ways to address these concerns. Taking necessary measures based on the participants' concerns and suggestions is crucial. Indeed, some countries are developing AI policy frameworks to facilitate the effective implementation of AI in classrooms (Wu, 2024). Therefore, policymakers must establish these frameworks to minimize issues related to privacy and security surrounding AI (Wu,

2024). Many countries are creating these frameworks to ensure the practical application of AI in classrooms and make it accessible to all (Yang & Huang, 2022). Additionally, conducting workshops to communicate these frameworks to administrators, teachers, and stakeholders can help alleviate these concerns. Indeed, there are studies consistent with the findings of this research, emphasizing that the use of AI in education raises similar concerns (Ayanwale et al., 2022; Lee et al., 2024). Additionally, situations where AI provides incorrect and misleading information can pose security threats (Jada & Mayayise, 2023). On the other hand, policymakers and educators have important roles in minimizing teachers' concerns about privacy and security regarding the use of AI in preschool. Therefore, policymakers and educators should adopt a positive attitude toward AI and accurately recognize the risks related to privacy and security (Luo et al., 2024). Furthermore, Ouyang and Jiao (2021) emphasized that AI presents ethical issues related to privacy and security that policymakers and educators should consider. In addition, many countries have begun efforts to develop AI policy frameworks for its application in preschool education (Wu, 2024). The foundation of all these policy frameworks is the effective implementation of AI during preschool (The State Council of the People's Republic of China, 2017). On the other hand, although program development related to AI is underway in the United States, there are concerns that digital technologies may not be suitable (Zhang & Aslan, 2021). Nevertheless, policy efforts are being made to integrate AI into preschool education. These efforts emphasize the importance of maintaining a balanced process between daily life and government policies to integrate AI (Lim, 2024). In this context, special protections should be implemented beyond teachers' concerns about privacy and security to reduce their anxieties. In early childhood education, only minimal, goal-oriented data should be shared instead of providing excessive data about children. Children should not be asked for more information than necessary. Secondly, to alleviate teachers' concerns, policies should be implemented to stop using children's information, take security measures according to design, and prevent violations of children's rights with strong commitment. Furthermore, through policies, measures should be taken to ensure that school administrations and families continuously monitor children's activities, and guidance should be provided to ensure their protection.

The sixth outcome of the research question revealed that participants expressed that using AI in preschool is appropriate. Some participants, however, mentioned that using AI in early childhood might not be suitable. Some participants emphasized that it was partially appropriate. Additionally, while most participants desired AI-related training, they emphasized that they did not want such training. Indeed, there are studies in the literature that align with the results of this research, indicating teachers' interest in receiving education on AI and the implementation of AI in early childhood (Druga & Ko, 2021; Kim & Kwon, 2023; Lin et al., 2022; Su & Zhong, 2022; Zhou, 2020;Yang, 2022). For example, Elliott and Soifer (2022) expressed concerns about various AI-related issues, such as acquiring personal data. Similarly, Lin et al. (2022) highlighted concerns about collecting information about teachers and students in their study. Jada and Mayayise (2023) emphasized teachers' concerns about ethical issues, technological infrastructure, and receiving education on AI. It is understood that there are many different reasons for the opinions of

teachers who emphasize that using artificial intelligence in the preschool period is inappropriate. It can be emphasized that these teachers are due to the privacy and security problems that artificial intelligence will create, ethical problems, and not having enough knowledge in this field. For this reason, teachers must receive training on these issues and raise awareness. Some studies emphasize that using AI in preschool is unsuitable for children's development (e.g., Zhang & Aslan, 2021). Similarly, Yang (2022) highlighted that the lack of clarity regarding the basic AI concepts to be taught to children in early childhood education and how to teach these concepts will negatively impact the implementation of AI in preschool.

The seventh outcome of the research question highlighted participants' concerns about various issues, such as lack of knowledge about artificial intelligence (AI), lack of physical conditions, insufficient infrastructure, and shortage of materials. Furthermore, teachers provided some recommendations for addressing their concerns related to AI. They suggested that providing training on AI, addressing infrastructure deficiencies, offering education on AI ethics, privacy, and security, and ensuring changes in teachers' attitudes toward AI would alleviate these concerns. These results highlight preschool teachers' professional barriers to effectively implementing AI in their classrooms. Therefore, developing professional development programs to alleviate these concerns is essential so teachers can apply AI in their classrooms. Teachers need sufficient knowledge about AI to improve their performance in implementing AI in classrooms (Park et al., 2023). Therefore, teachers' low self-efficacy in AI could pose a barrier to effective teaching (Çelik, 2023) and cause apprehensions about implementing AI in classrooms. Hence, teachers must receive education on AI to alleviate their concerns (Su et al., 2023). Besides the lack of knowledge, factors such as material shortages and infrastructure deficiencies also contribute to teachers' concerns. The literature emphasizes that providing material support, infrastructure support, and teacher and student guides are crucial (Lindner & Romeike, 2019; Mondal et al., 2023; Su, 2024b). Considering all these concerns, efforts should be made to reduce individuals' ethical concerns and anxieties regarding AI starting from early childhood (Kong et al., 2022, 2023; Long & Magerko, 2020; Ng et al., 2021). Furthermore, schools should be equipped with these technologies to enrich the educational environment with AI for students (Su & Zhong, 2022). Teachers should be trained on cybersecurity, data protection, data manipulation, and malware to reduce concerns about privacy and security (Balaban, 2024). In addition, removing and constantly reviewing the access permissions given for artificial intelligence applications is important. On the other hand, if prediction studies will be carried out with students, it is also essential that teachers use codes instead of giving direct information about students.

5 Conclusion

In terms of the research questions, the results obtained in the study are presented in detail. The first result from the study indicates that preschool teachers are not sufficiently competent in AI literacy and proficiency. Preschool teachers emphasized that they lack knowledge of AI, AI applications, AI tools, and issues related to privacy

and security. Another result from the study pertains to preschool teachers' views on activities involving AI. Teachers stated that AI could be used in various activities like mathematics, coding, and science. Preschool teachers also mentioned that using AI in early childhood education could contribute to developing various skills, including creativity, AI literacy, communication, and critical thinking. Another result from the study concerns privacy and security. Teachers highlighted that using AI in preschool education might lead to privacy and security issues, such as misusing videos, images, and data. Teachers also suggested that these privacy and security concerns could be addressed through parental control, teacher control, not entering personal data, and not sharing images. Another finding from the study relates to the use of AI in early childhood education. Most preschool teachers emphasized that using AI in preschool education is appropriate. Teachers also stated that it is important for them to receive training in this area to integrate AI into their classrooms. Furthermore, to effectively use AI in classroom settings, teachers need to be knowledgeable in areas such as AI knowledge, AI practical knowledge, AI literacy, and AI ethics. A further result concerns the teachers' concerns and suggestions regarding the use of AI. Teachers reported several challenges, including insufficient knowledge, unsuitable physical conditions, and inadequate infrastructure. Teachers also suggested that these issues could be resolved by receiving AI training, strengthening infrastructure, and providing education on AI ethics, privacy, and security.

5.1 Recommendation

Based on the results obtained within the scope of the study, recommendations have been made for future research. Firstly, there is a need for robust pedagogical training on AI to ensure preschool teachers have sufficient knowledge and skills in AI. This training should include AI content knowledge, AI literacy, AI ethics, AI pedagogy, AI security and privacy, and attitudes towards AI. Secondly, it is understood that teachers have various concerns about implementing AI in their classrooms. To address these concerns, schools can strengthen their infrastructure related to AI, ensure appropriate physical infrastructure in classrooms, create content for teachers and students associated with AI, and provide expert support on AI. Thirdly, long-term studies are needed to reveal the effects of AI in the preschool period from both the teacher and student dimensions. Fourthly, since AI applications can be used in various activities such as coding, science, mathematics, and storytelling, sample activities for preschool education can be designed to incorporate AI into these activities.

The availability of tools such as instructional AI robots and kits designed for this age group should be increased to build AI literacy in preschool children. Resources like animations and stories tailored to students' age groups can also be developed to enhance AI literacy. PD programs can be offered to help preschool teachers develop these instructional tools and resources. For instance, such training could enable preschool teachers to create stories and digital materials using AI. Similarly, when AI is integrated, teachers can develop AI-supported lesson plans for classroom environments. AI can assist teachers in developing and improving lesson plans.

Policymakers should establish privacy and security guidelines to address issues related to privacy and security in preschools. Cybersecurity training should be provided to address teachers' concerns about ethics, privacy, and security related to AI. Moreover, permissions such as access to the camera should be restricted to limit AI's access to sensitive information. Assigning code names to students can also help alleviate ethics, privacy, and security concerns. Allocating the necessary budget is crucial to effectively implementing AI in classrooms. This budget should strengthen the learning environment infrastructure and purchase the required equipment. Policymakers and educators should propose fundamental principles for designing and implementing an AI preschool curriculum. Finally, the results of this study highlight the challenges preschool teachers may face when implementing AI in their classrooms and encourage policymakers and educators to provide relevant training for preschool teachers. In this context, to facilitate the implementation of AI in ECE:

1. A professional development program on AI literacy could be developed for preschool teachers, covering how AI works, how to integrate it into activities, how to use it in these activities, and privacy, security, and ethics issues. Additionally, mentoring programs could be established to support teachers during the implementation process in preschool classrooms. Furthermore, countries could develop AI policy frameworks related to this matter.
2. Research can be conducted on the effects of AI in developing various skills, such as problem-solving, in preschool-aged children. These studies can utilize AI-based games and applications, such as storytelling integrated with AI.
3. Large-scale studies focusing on privacy, security, and ethics—key factors influencing the effective use of AI in classrooms could be conducted for children. Additionally, content can be created for seminars aimed at administrators, teachers, and parents.
4. Experimental studies could be conducted to examine the effects of AI-supported learning applications on children during the preschool period. For example, the effects of simple AI games that teach children the logic of algorithms could be investigated.
5. Investigative studies could be conducted to explore children's abilities using AI in preschool education.
6. Research could be undertaken to understand preschool teachers' challenges when integrating AI into their educational processes and identify their needs regarding AI. In addition, digital platforms could be established to support teachers in integrating AI into their classrooms.

5.2 Limitations

This study has several limitations. The study included preschool teachers' views on artificial intelligence applications in the preschool period. This is the first limitation of this study. It includes opinions about the application of artificial intelligence in the preschool period. The second limitation of the study is that it was conducted using a phenomenological design, one of the qualitative research methods.

Appendix 1

Interview questions

1. Do you feel competent and literate in artificial intelligence? Explain
2. What are your views on artificial intelligence?
3. What skills do you think using artificial intelligence will develop in children?
4. Do you have any security and privacy concerns about AI? Explain
5. Do you think it is appropriate to use artificial intelligence in preschool education? Explain
6. What are your views on receiving training on artificial intelligence?
7. What qualifications are required for teachers to use AI in the classroom?
8. What are the concerns about implementing artificial intelligence, and what are your suggestions for solutions?

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Data availability The datasets generated during and analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethical considerations The data for this study were collected voluntarily from preschool teachers. I am grateful to all the teachers who participated in this process.

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article.

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