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Research Insights
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EXPLORING FACTORS DETERMINING THE ATTITUDES OF PROSPECTIVE PRIMARY TEACHERS TOWARDS THE USE OF ARTIFICIAL INTELLIGENCE IN SCIENCE EDUCATION

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Abstract. This study aims to contribute to the ongoing discourse by examining the subject-specific integration of AI, focusing on how prospective teachers perceive, engage with, and adapt these tools to create personalized and differentiated science learning experiences. The aim of this study is to explore the factors influencing the attitudes of prospective primary teachers toward using ChatGPT in primary science teaching. Both qualitative and quantitative methods were employed to ensure comprehensive analysis in this study. Data on preservice teachers' attitudes, shaped by emotional, cognitive, and experiential factors, and on the potential application of ChatGPT-3.5 in education were collected through two questionnaires and a detailed analysis of documents containing differentiated learning tasks prepared by preservice teachers. The step-by-step sequence of the intervention and the results are described. The results gathered in the process of the study indicate that the factors determining preservice teachers' attitudes towards Al can be categorized into four major groups as follows emotional, cognitive and experiential influences as well as potential barriers, each of which is divided into sub-factors categorized in the study. The study explains and highlights the interplay and interdependence of these factors in shaping preservice teachers' readiness to integrate Al into elementary science education. From a research perspective the results of this study may encourage arousing research on the use of AI for educational purposes in various sociocultural environments, as well as the development of university-based professional development programs for in-service and pre-service teachers that are tailored to the characteristics of different subject-specific didactics.

Keywords: GenAI; ChatGPT; primary science education; instructional design; pre-service teachers

Introduction

The traditional explanatory-illustrative approach has long dominated elementary science teaching, relying on teacher-led instruction paired with structured questions and textbook assignments to reinforce student understanding. While effective

in delivering knowledge, this approach has limitations in fully engaging diverse learners and successfully developing competences. Emerging technologies, particularly artificial intelligence (AI), offer transformative potential for creating more inclusive and student-centered science education. Y. Doncheva (2024) notes that traditional tools like whiteboards and projectors have evolved into more advanced supports such as learning management systems and video streaming, which reshaping the design of teaching and learning. R. Peytcheva-Forsyth (2018) emphasizes the reciprocal relationship between students' attitudes toward ICT in education and their perceptions of distance learning, noting that a positive disposition toward ICT fosters a more favorable view of distance education, and vice versa. Furthermore, as Angelova & Terlemezyan (2023) emphasizes, these technological trends require teachers to develop a complex set of digital competencies, placing new demands on both their ongoing professional development and the university training of prospective educators. Integrating AI into the education process at the university level may equip prospective teachers with the necessary competencies to adopt it effectively, enabling the transition to more inclusive, personalized, social and emotional learning of primary science.

Literature review

The rapid development of artificial intelligence (AI) technologies is transforming educational practices, with tools like ChatGPT gaining prominence in supporting teaching and learning processes. Recent research emphasizes the growing importance of AI in enhancing pre-service teacher training, particularly in fostering personalized learning and differentiated instruction (Zhou et al. 2023). The integration of artificial intelligence (AI) into teacher education has gained increasing attention in recent years, driven by its potential to transform instructional practices and enhance teacher preparation.

Studies have begun to explore the role of AI tools, such as ChatGPT, in improving pre-service teachers' lesson planning and instructional strategies. For example, research by Lee and Zhai (2024) examined how pre-service elementary teachers utilized ChatGPT in science education, demonstrating its ability to facilitate diverse and innovative teaching methods. Similarly, the development of systems like Collaborative Learning with AI Speakers (CLAIS) highlights the role of AI in fostering collaborative learning among pre-service elementary science teachers (Lee et al. 2023). These advancements reflect the growing integration of AI tools into teacher education, emphasizing their potential to prepare educators for modern, technology-driven educational process.

One critical aspect of AI integration in education is its capacity to assist educators in addressing diverse student needs. Studies by Montenegro-Rueda et al. (2022) highlight that AI tools can streamline lesson planning by generating adaptable and inclusive materials. The findings of his study apply to education in all fields, but are

particularly relevant to primary science education, where teachers must simplify complex concepts while catering to varying student abilities. In spite of that, questions remain about whether pre-service teachers possess the confidence, skills, and disposition necessary to leverage AI effectively in their future teaching practice.

Teachers' attitudes toward AI tools have been linked to their emotional responses and perceived usefulness. In his research Almasri also revealed that AI-powered tools are integrated into science education to achieve various pedagogical benefits, including enhancing the learning environment, creating quizzes, assessing students' work, and predicting their academic performance (Almasri 2024). Positive engagement with AI often correlates with increased willingness to integrate such tools into teaching. Conversely, negative emotions such as anxiety and uncertainty can create significant barriers. This is especially true for novice educators, who may lack familiarity with technology-driven solutions, as discussed by Schmidt et al. (2023). These emotional and cognitive factors are essential for understanding the adoption of ChatGPT, which requires not only technical proficiency but also trust in its capacity to support pedagogical goals.

A study published in Frontiers in Psychology explored pre-service teachers' GenAI anxiety, technology self-efficacy, and their intention to design GenAI-assisted teaching. The research found that GenAI anxiety, social influence, and performance expectancy significantly predicted teachers' behavioral intention to use GenAI in teaching (Wang & all 2024).

Research gap

A recurring limitation in existing studies is the lack of focus on primary science teaching and learning and prospective teachers education. An analysis of the latest publications reveals a lack of understanding regarding how pre-service teachers perceive, engage with, and integrate such tools into science lesson planning and instructional design. Most research generalizes AI's application across education, overlooking the distinct demands of primary science teaching. As pointed out by Hojeij et al. (2024), effective AI integration must align thoughtfully with the shift towards student-centered approaches and the demands of 21st-century skills, particularly in fostering inquiry, experimentation, and critical thinking. This highlights the need for studies exploring how pre-service teachers utilize AI tools to design engaging and differentiated science lessons that promote conceptual understanding in young learners. Understanding these dynamics is essential for addressing barriers to adoption and equipping future educators with the skills needed to use AI effectively. This study aims to address these gaps by exploring how pre-service teachers interact with ChatGPT to create personalized and differentiated learning experiences in primary science education, thereby contributing to the development of AI-literate educators and more effective prospective teacher training programs.

While much of the existing literature emphasizes the technical capabilities of AI and its application in secondary and higher education, research specifically addressing the pedagogical challenges and emotional responses faced by prospective teachers in elementary science education remains limited.

In summary, current studies do not explore how tools like ChatGPT-3.5 can be utilized to meet the unique demands of primary science teaching, such as fostering differentiation and adapting instruction to stimulate social and emotional learning. Although the transformative potential of AI is well-documented, there is a notable gap in understanding how prospective primary teachers engage with AI tools during their training and initial practice. This gap is particularly significant when examining the relationship between teachers' attitudes, pedagogical and content knowledge, and the adoption of AI in creating inclusive and student-centered learning environments. To address this gap, it is crucial to scientifically research how AI tools like ChatGPT-3.5 can be effectively and meaningfully integrated into university-based teacher education programs to prepare future educators for the complexities of primary science teaching.

This study aims to contribute to the ongoing discourse by examining the subject-specific integration of AI, focusing on how prospective teachers perceive, engage with, and adapt these tools to create personalized and differentiated science learning experiences.

Since the attitudes of pre-service teachers toward educational technologies that utilize artificial intelligence (AI) can have a significant impact on the learning outcomes of their future students, it is essential to gain a deeper understanding of how these technologies are accepted by them.

The aim of this study is to explore the factors influencing the attitudes of prospective primary teachers toward using ChatGPT in primary science teaching. Specifically, the study seeks to identify the determinants of their attitudes toward adopting ChatGPT, including the role of beliefs, emotions, prior experiences, and other contextual variables that shape their perceptions of AI-based educational tools. The term "attitudes" in this study refers to the overall evaluation that students express toward AI. Attitudes are understood as a relatively enduring and general evaluation of an object, person, group, issue, or concept on a dimension ranging from negative to positive. Attitudes provide summary evaluations of target objects and are often assumed to be derived from specific beliefs, emotions, and past behaviors associated with those objects[1]. This definition emphasizes the multidimensional nature of attitudes, encompassing cognitive, affective, and behavioral components that influence how individuals perceive and interact with AI tools.

Research Questions: What factors influence prospective teachers' attitudes to use ChatGPT in primary science education, and how do these factors interact with each other in the process of shaping attitudes?

Hypothesis: Prospective teachers who experience positive emotions, such as confidence or curiosity, and find the use of ChatGPT engaging and enjoyable, are more likely to feel comfortable using AI-based tools in their future teaching practices.

Methodology

The study was conducted in the first semester of 2024/2025 academic year. The sample consisted of 94 students studying in their fourth-year university program in specialty of preschool and primary school pedagogy and primary school pedagogy with foreign language at the Pedagogical Faculty at Paisii Hilendarski University of Plovdiv. The participants were female students with a mean age of 22.05 years and a standard deviation (SD) of the participants' age of 0.54. The study and the experimental intervention took place within the academic course "Didactic of Education in Man, Nature and Society" and pre-service practice students conducted at school.

Both qualitative and quantitative data were employed to ensure comprehensive analysis in this study. This methodology included tailor-made pre- and post-questionnaires, specifically designed for this research, alongside document analysis. The data about prospective teachers' attitudes—shaped by emotional, cognitive, and experiential factors—and the potential application of ChatGPT-3.5 in education were gathered through these questionnaires and the analysis of generated documents containing differentiated instructional tasks.

The questionnaires consisted of two types of questions: closed-ended questions measured on a Likert scale and open-ended questions. These were designed to assess how beliefs, emotions, and contextual factors influence attitudes, as well as to evaluate the functionality, accessibility, satisfaction, and likelihood of ChatGPT-3.5 being utilized in teaching primary science.

The study followed a structured sequence of activities designed to familiarize participants with ChatGPT-3.5 and assess its application in creating instructional tasks for primary science education. The procedure consisted of four key stages, beginning with an introduction to ChatGPT-3.5. Participants were provided with a detailed explanation of the tool's characteristics, capabilities, and potential applications in education. This introductory session included a demonstration of how ChatGPT-3.5 could be utilized to create learning tasks, support differentiation by instructional materials tailored to diverse student needs.

Participants were then given step-by-step instructions for using ChatGPT-3.5, including practical examples of how to generate learning tasks to achieve the expected outcomes set out in the curriculum and ask content-specific questions. This stage aimed to build participants' confidence and competence in using the tool effectively. During this phase, participants engaged in guided practice under the direct supervision of the lecturer, who provided immediate feedback, addressed questions, and facilitated discussions on potential challenges and solutions.

After the guided practice, participants were assigned an independent task that required them to develop differentiated instructional activities using ChatGPT-3.5. These tasks had to reflect the principles of personalized learning and include specific components such as objectives, instructions, and assessment criteria. Participants were encouraged to apply creativity while ensuring that the tasks aligned with the curriculum. This allowed them to explore the functionality of ChatGPT-3.5 in a practical context and reflect on its potential for enhancing their teaching practices.

The final stage involved the submission and presentation of the completed assignments. Participants uploaded their tasks to a shared online platform (Google Classroom), where they were reviewed by peers and the lecturer. The presentations gave participants the opportunity to explain their choice of learning design, discuss the role of ChatGPT-3.5 and receive constructive feedback. This stage also facilitated a collaborative learning environment in which participants could share insights, challenges, and strategies for effectively integrating artificial intelligence, which contributes to improving their competencies for professional communication and collaboration.

Results and Discussion

The findings collected from the entire research process indicate that factors determining prospective teachers' attitudes can be categorized into four main groups, each with specific sub-factors:

1. ***Emotional Factors***

1.1. Confidence

1.2. Curiosity

1.3. Enjoyment

1.4. Anxiety (Discomfort, Uncertainty)

2. ***Cognitive Factors***

2.1. Belief in AI usefulness for improving ability to plan and assess learning tasks

2.2. Advancement in designing learning tasks for differentiation and social-emotional learning

3. ***Experiential Factors***

3.1. Prior AI Exposure

3.2. Ease of Use and convenient to facilitate teaching

4. *Barriers to Adoption*

4.1. Limited familiarity and practical experience in utilizing ChatGPT for enhancing learning

4.2. Ethical Concerns

4.3. Fear of AI Error

These categories highlight the interplay of emotional, cognitive, and experiential influences, as well as potential barriers, shaping pre-service teachers' readiness to integrate AI into primary science education.

The preliminary questionnaire data showed that only 11% of respondents had registered for the free version of ChatGPT-3.5, with none using the paid version. Participants primarily utilized the tool for supporting course work or conducting general information searches. This indicates that prospective teachers' prior experience with ChatGPT-3.5 was limited and not subject-specific related to science teaching. These findings underscore the need for targeted training within academic courses in science didactics to equip prospective teachers with the skills and confidence needed to integrate AI effectively into primary science education.

The post-questionnaire consists of fifteen questions assessing the factors determining prospective primary teachers' attitudes toward Al use across four dimensions: emotional, cognitive, experiential and barriers to adoption, each represented by sub-factors. The data obtained by the research are presented visually at Figure 1.

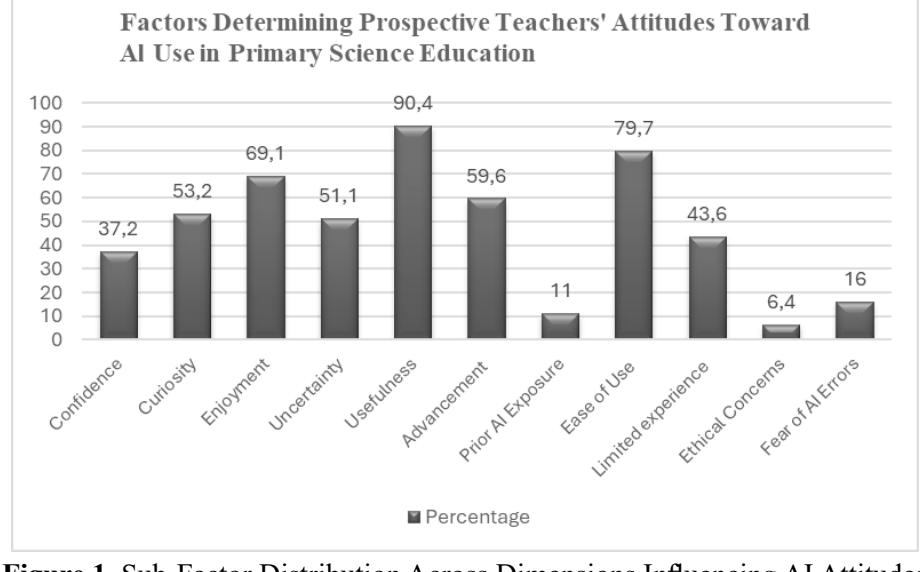

Figure 1. Sub-Factor Distribution Across Dimensions Influencing AI Attitudes

Emotional responses play a significant role in shaping pre-service teachers' attitudes toward the adoption of new technologies like ChatGPT-3.5. The findings reveal that 53.2% of participants felt curious to use ChatGPT-3.5, also 37,2 % reported confidence and 69,1% felt enjoyment. At the same time 51,1 % expressed anxiety like discomfort or uncertainty when engaging with AI tools. These findings highlight the dual nature of emotional responses, emphasizing the need for supportive and structured training in the subject-oriented context to enhance confidence and reduce anxiety when integrating AI into pre-service primary teacher training in science education.

The analysis of the designed learning tasks aimed at differentiation and social-emotional learning in science showed that they were varied and methodologically sound, which is consistent with the opinion of 59.6% of all respondents who reported that they had made progress in developing learning tasks for differentiation and social-emotional learning.

The main shortcomings of the presented learning tasks are the lack of consistency with the spelling rules of the Bulgarian literary language for the design of test tasks, as well as with the requirements of the regulation for the assessment of students' achievements.

Barriers to the use of AI in preservice teachers' teaching practice were categorized as insufficient experience and knowledge in using ChatGPT and, to a lesser extent, ethical considerations and fear of receiving erroneous information from the chatbot.

Conclusion

This study offers insights into the factors that influence preservice elementary teachers' adoption of AI and how their targeted training in subject-specific didactics courses can influence their willingness to use ChatGPT to achieve more effective science learning and teaching.

The factors presented in this study affect the complex attitudes of prospective primary teachers towards the use of AI and can be used as a set of benchmarks for the development of didactics curricula of different subjects' areas.

Emotional factors such as confidence, curiosity, enjoyment, and anxiety influence pre-service teachers' disposition to use ChatGPT in primary science education. Confidence encourages exploration and integration of the tool, while curiosity fosters openness to its potential. Enjoyment and interest make the experience engaging, increasing motivation to adopt AI in teaching. When pre-service teachers feel confident in their ability to navigate AI tools, they are more likely to perceive these tools as valuable aids in enhancing their teaching practices. Engagement, characterized by enjoyment and interest, further increases positive attitudes towards ChatGPT adoption.

The factors identified in this study and their described relationships support the hypothesis that pre-service teachers who experience positive emotions, such as confidence or curiosity, and find using ChatGPT engaging and enjoyable are more likely to feel comfortable using AI-based tools to create learning tasks that provide differentiation, personalization, and social-emotional learning in elementary science education.

This research supports the importance of targeted training in didactics courses in both science and all other subjects in order to give prospective teachers the necessary experience and confidence to successfully incorporate AI as an assistive tool in prospective teachers' practice.

Limitations and future directions

The acceptance of technology by teachers is essential for effective implementation. However, this study only considers the perspective of pre-service primary teachers who have limited experience in a real classroom environment. Future research should also consider in-service teachers' attitudes, which are determined by different factors such as educational policies, requirements of the school management, technical resources and many more.

From a research perspective the results of this study may encourage arousing research on the use of AI for educational purposes in various sociocultural environments, as well as the development of university-based professional development programs for in-service and pre-service teachers that are tailored to the characteristics of different subject-specific didactics.

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NOTES

1. APA Dictionary of Psychology - https://dictionary.apa.org/attitude

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