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Mathematics Education Students' Perceptions in Designing AI-Assisted Mathematics Problems: A Case Study of Agricultural Context

Adang Effendi, Ai Tusi Fatimah, Ida Nuraida

Abstract

The rapid advancement of generative artificial intelligence (AI) has opened new opportunities in education, particularly in supporting mathematics problem design. This study investigates the perceptions and intentions of prospective mathematics teacher students regarding the use of generative AI as a tool for designing context-based mathematics problems related to corn cultivation. Employing a mixed-methods approach with an exploratory sequential design, data were collected from mathematics education students enrolled in an Applied Mathematics course through questionnaires and semi-structured interviews. The research procedure implemented a series of hierarchical challenges in problem design, progressing from general agricultural contexts to more specific applications involving corn shelling technology. This design aimed to examine how students adapted their use of AI as the level of contextual complexity increased. Quantitative data were analyzed using descriptive statistics to examine students' perceptions and intentions, and inferential statistics to identify differences based on demographic characteristics. Qualitative data were analyzed thematically to capture participants' experiences and reflections. The findings indicate that students demonstrated highly positive perceptions of generative AI, recognizing it as a valuable tool for enhancing digital competence, supporting career development, and facilitating the design of contextual mathematics problems. Participants also reported high levels of comfort and strong intentions to integrate AI into their future teaching practices. However, the frequency of AI use was moderate, reflecting participants' awareness of the technology's limitations. No significant differences in perceptions or intentions were found based on gender or prior experience with corn cultivation. Qualitative results revealed that AI functioned as an effective collaborative and iterative tool for idea generation, while challenges such as limited contextual realism, rigid responses, potential logical errors, and concerns about overreliance were noted. The study concludes that while prospective teachers hold positive attitudes toward generative AI, there is a critical need to strengthen AI literacy, critical thinking, and ethical awareness through targeted integration in mathematics teacher education programs.

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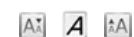
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Mathematics Education Students' Perceptions in Designing AI-Assisted Mathematics Problems: A Case Study of Agricultural Context

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ABSTRACT

The rapid advancement of generative artificial intelligence (AI) has opened new opportunities in education, particularly in supporting mathematics problem design. This study investigates the perceptions and intentions of prospective mathematics teacher students regarding the use of generative AI as a tool for designing context-based mathematics problems related to corn cultivation. Employing a mixed-methods approach with an exploratory sequential design, data were collected from mathematics education students enrolled in an Applied Mathematics course through questionnaires and semi-structured interviews. The research procedure implemented a series of hierarchical challenges in problem design, progressing from general agricultural contexts to more specific applications involving corn shelling technology. This design aimed to examine how students adapted their use of AI as the level of contextual complexity increased. Quantitative data were analyzed using descriptive statistics to examine students' perceptions and intentions, and inferential statistics to identify differences based on demographic characteristics. Qualitative data were analyzed thematically to capture participants' experiences and reflections. The findings indicate that students demonstrated highly positive perceptions of generative AI, recognizing it as a valuable tool for enhancing digital competence, supporting career development, and facilitating the design of contextual mathematics problems. Participants also reported high levels of comfort and strong intentions to integrate AI into their future teaching practices. However, the frequency of AI use was moderate, reflecting participants' awareness of the technology's limitations. No significant differences in perceptions or intentions were found based on gender or prior experience with corn cultivation. Qualitative results revealed that AI functioned as an effective collaborative and iterative tool for idea generation, while challenges such as limited contextual realism, rigid responses, potential logical errors, and concerns about overreliance were noted. The study concludes that while prospective teachers hold positive attitudes toward generative AI, there is a critical need to strengthen AI literacy, critical thinking, and ethical awareness through targeted integration in mathematics teacher education programs.

Keywords: *generative artificial intelligence; mathematics teacher education; context-based mathematics problems; prospective mathematics teachers; AI literacy and ethics.*

ABSTRAK

Perkembangan pesat kecerdasan buatan generatif (generative artificial intelligence/AI) membuka peluang besar dalam bidang pendidikan, khususnya dalam mendukung perancangan soal matematika kontekstual. Penelitian ini bertujuan untuk menganalisis persepsi dan intensi mahasiswa calon guru matematika terhadap penggunaan AI generatif sebagai alat bantu dalam merancang soal matematika yang relevan dengan konteks budaya jagung. Penelitian ini menggunakan pendekatan *mixed-methods* dengan desain *exploratory sequential*. Data dikumpulkan dari mahasiswa pendidikan matematika yang mengikuti mata kuliah Matematika Terapan melalui kuesioner dan wawancara semi-terstruktur. Prosedur penelitian menerapkan serangkaian tantangan hierarkis dalam perancangan soal, dimulai dari konteks pertanian secara umum hingga aplikasi yang lebih spesifik pada teknologi pemipilan jagung, dengan tujuan mengamati adaptasi penggunaan AI seiring meningkatnya kompleksitas konteks. Data kuantitatif dianalisis menggunakan statistik deskriptif untuk menggambarkan persepsi dan intensi mahasiswa, serta statistik inferensial untuk menguji perbedaan berdasarkan karakteristik demografis. Data kualitatif dianalisis secara tematik untuk menggali pengalaman dan narasi mahasiswa. Hasil penelitian menunjukkan bahwa mahasiswa memiliki persepsi nilai yang sangat positif terhadap AI, memandangnya sebagai aset penting untuk pengembangan kompetensi digital dan kesiapan karier, serta merasa nyaman dan terbantu dalam menggunakan AI untuk merancang soal matematika kontekstual. Mahasiswa juga menunjukkan intensi yang kuat untuk mengintegrasikan AI dalam praktik pembelajaran di masa depan. Namun, frekuensi penggunaan AI tergolong sedang, mencerminkan pemahaman mahasiswa terhadap keterbatasan teknologi tersebut. Tidak ditemukan perbedaan signifikan dalam persepsi dan intensi berdasarkan jenis kelamin maupun pengalaman menanam jagung. Secara kualitatif, AI dipandang sebagai alat kolaboratif dan iteratif yang efisien untuk pengembangan ide, meskipun masih ditemui tantangan seperti kurangnya realisme konteks, respons yang kaku, potensi kekeliruan logis, dan kekhawatiran ketergantungan. Penelitian ini menegaskan sikap positif mahasiswa terhadap AI generatif sekaligus menyoroti pentingnya penguatan literasi AI, berpikir kritis, dan etika penggunaan AI dalam kurikulum pendidikan calon guru matematika.

Kata kunci: kecerdasan buatan generatif; pendidikan guru matematika; soal matematika kontekstual; calon guru matematika; literasi dan etika AI.

A. INTRODUCTION

The rapid development of digital technology has driven the world of education to transform significantly (Smith, 2025). The emergence of generative artificial intelligence (AI), especially large language models such as ChatGPT, has brought a new paradigm to the learning and teaching process at various levels, including higher education (Fenta, 2025; Qian, 2025). Generative AI is a tool and partner for users who can generate creative ideas, texts, and content, thus opening up very broad opportunities for innovation in the world of education (Qian, 2025). Generative AI

models such as ChatGPT and Bard can enhance the learning experience for users by providing personalized content, quizzes, and explanations, and acting as virtual tutors that provide very instant feedback (Fenta, 2025; Yusuf et al., 2025). This phenomenon requires educators to understand, adapt, and leverage the potential of AI to prepare students for the challenges of the digital era, as well as address concerns about academic integrity, data privacy, and potential dependence on AI (Krause et al., 2025; Maxwell et al., 2025; Mulaudzi & Hamilton, 2025).

In the context of mathematics education, one of the competencies for prospective teachers is the ability to design mathematics problems that are relevant to student characteristics and the objectives of teaching and learning activities. Designing mathematics problems using AI is possible for prospective teachers because of its ability to personalize teaching, adaptive assessment, interactive learning environments, and real-time feedback (Opesemowo & Ndlovu, 2024). Tools such as ChatGPT, for example, can help in understanding mathematical concepts, planning lessons, designing assessments, and supporting personalized learning (Pepin et al., 2025). In addition, AI can also improve responsive teaching skills for prospective teachers through interactions with AI-based chatbots that act as virtual students, which can influence teachers' questioning practices and their ability to "pay attention" to student responses (Lee et al., 2025). Therefore, educators need to adapt to this technology. This has led to a shift in teaching methodology and an understanding of how pre-service teachers view the relevance and challenges of integrating AI into mathematics teaching (Bernardi et al., 2025). Teacher competencies also include the ability to develop theoretical frameworks in integrating AI chatbots to enhance students' mathematical problem-solving competencies (Chau et al., 2025). Given the potential and challenges of AI, teachers need to balance AI-driven developments with core pedagogical principles, and initiate and reflect on AI-generated responses for ongoing professional development (Bernardi et al., 2025; Opesemowo & Ndlovu, 2024).

This study specifically focuses on the perceptions of mathematics education study program students regarding the use of AI in

designing mathematics problems that are relevant to the agricultural context, especially for students of Food Crops and Horticulture Agribusiness Vocational High Schools. The selection of this context is very relevant because mathematical understanding and reasoning are key to solving various problems in the agricultural sector (Fatimah & Prabawanto, 2020). The curriculum of Agribusiness Vocational High Schools, which is an integral part of the STEAM-H (Science, Technology, Engineering, Agriculture, Mathematics, and Health) field, inherently requires cross-subject connections between mathematics and science to solve increasingly complex and challenging agricultural problems (Fatimah et al., 2023). The integration of AI in designing these contextual problems is expected to bridge the gap between mathematical theory and its application in the field, while also answering the needs of the dynamic agricultural industry for skilled and knowledgeable workers (Chondrogiannis et al., 2021). However, this study also recognizes the challenges that AI integration may pose, such as potential negative impacts on interpersonal interactions and critical thinking development among vocational education students, making it important to establish guidelines and promote activities that encourage self-directed learning (Ododo et al., 2024). By leveraging AI to support contextual problem design, such as scenario-based simulations and guided problem-solving models (Choustoulakis, 2024), this study aims to generate problems that not only test conceptual understanding but are also relevant to practices in the agribusiness workplace.

To explore students' perceptions of the use of AI to help design mathematical problems, this study involved a series of four challenges designing increasingly specific and complex problems. Starting from the general context of agriculture, narrowing down to corn cultivation, then the use of corn husking

machine technology, to the combination of data analysis with the context of the technology. This hierarchical approach allowed researchers to observe the evolution of students' perceptions as the specificity and complexity of the task increased, as well as their ongoing interaction with AI. The integration of AI in educational applications, although offering many opportunities, also presents significant challenges that can affect students' creativity and academic emotions, such as the potential limitations of creative thinking and performance anxiety (Lin & Chen, 2024). While AI has the potential to facilitate personalization and automation of tasks (Ahmed et al., 2024), it is important to explore how students navigate the balance between using AI for efficiency and dependence that can hinder the development of cognitive and metacognitive skills (Ahmed et al., 2024). Thus, this study aims to identify how mathematics education students utilize AI for complex and creative tasks in designing mathematical problems. This study will also look at how students perceive their knowledge of the limitations and potential of AI, perceive the value and costs of its use, and see their intentions to integrate it in the future in higher education settings (Folmeg et al., 2024).

This study is expected to provide valuable insights into the perceptions of mathematics education students towards the use of AI in designing mathematics problems. Understanding their views and abilities towards AI integration is essential to prepare them for the changing identity of a teacher in the era of AI-integrated education (Guan et al., 2025). Although previous studies have shown students' positive attitudes towards AI and their comfort in using it for academic productivity and success (Ahmed et al., 2024; Folmeg et al., 2024; Maxwell et al., 2025), many still do not fully understand the

basics of AI and the ethics of its use, and tend to view AI only as a tool rather than a dynamic collaborator (Guan et al., 2025). Concerns related to academic integrity, over-reliance, data privacy, potential bias, and barriers to critical thinking also remain significant issues in the use of AI by students (Ahmed et al., 2024; Maxwell et al., 2025; Opesemowo & Ndlovu, 2024). Therefore, the results of this study will be highly relevant for the development of teacher education curricula, identifying factors that influence students' intention to utilize AI-based educational applications, and highlighting potential differences in perceptions based on gender (Zhang et al., 2023). The findings of this study will contribute to a deeper understanding of the future direction of AI in teacher education, identifying specific teacher training needs for success in AI-supported learning environments (Guan et al., 2025), and its application to pedagogical practice. This will serve as a foundation for further research on the role of AI in mathematics learning innovation, particularly to support the relevance of vocational education and prepare a future generation of educators who are competent, adaptive, and have strong AI literacy, in line with the call for a more systematic introduction and discussion of AI literacy in higher education settings (Folmeg et al., 2024; Karkouloulian et al., 2024; Maxwell et al., 2025).

Generative Artificial Intelligence in Education

The emergence of generative artificial intelligence (AI) in large language models such as ChatGPT has triggered an information revolution (Yu & Guo, 2023) and brought new changes to the learning and teaching process at various levels, including higher education (Fenta, 2025; Jensen et al., 2025). ChatGPT, which was first released on November 30, 2022, has attracted global attention with one million subscribers in a week due to its

advanced ability to solve highly complex tasks (Baidoo-Anu & Owusu Ansah, 2023). Generative AI is a potential partner capable of creating original content, such as text, images, and sound (Alier et al., 2024), which is highly innovative (Qian, 2025). The emergence and advancement of generative AI technology dominates all aspects of social life as well as education (Mao et al., 2024). Bibliometric analysis shows significant and exponential growth in generative AI research in education by 2023, with ChatGPT emerging as a dominant generative AI tool (Bahroun et al., 2023; Samala et al., 2025).

Generative AI in higher education is used in a very broad context. This generative AI can enhance the learning experience by providing personalized content, quizzes, and explanations, and acting as a virtual tutor that provides very fast feedback (Fenta, 2025; Yu & Guo, 2023; Yusuf et al., 2025). The use of generative AI as an assessment tool with fast feedback, such as creating custom quizzes or grading essays, reduces the workload of teachers (Alier et al., 2024). Generative AI is a catalyst for pedagogy for personalized learning and inclusion (AlAli & Wardat, 2024; Jensen et al., 2025), assisting in lesson planning and assessment design (Pepin et al., 2025). These benefits of generative AI encourage dynamic and immersive learning interactions, such as encouraging personalized and interactive learning, and generating prompts for formative assessment activities (Baidoo-Anu & Owusu Ansah, 2023). AI integration can support pedagogical applications and cognitive-processual goals (Yusuf et al., 2025), and stimulate creativity by introducing new ideas and problem-solving techniques (Lin & Chen, 2024).

Despite the enormous benefits of generative AI, its implementation in education is also

accompanied by significant challenges and concerns. Issues that are highlighted include violations of academic integrity, the risk of over-reliance on AI, and privacy and data security issues (Ahmed et al., 2024; AlAli & Wardat, 2024; Alier et al., 2024; Baidoo-Anu & Owusu Ansah, 2023; Choustoulakis, 2024; Maxwell et al., 2025; Yu & Guo, 2023). Concerns have also been raised about the potential for AI to produce factually inaccurate information (Baidoo-Anu & Owusu Ansah, 2023; Pepin et al., 2025), bias in data and algorithms (AlAli & Wardat, 2024; Opesemowo & Ndlovu, 2024), and the inability of AI to explain, incorporate or demonstrate emotional intelligence (Opesemowo & Ndlovu, 2024; Yu & Guo, 2023). Furthermore, there are concerns that AI may hinder the development of important skills such as critical thinking (Ahmed et al., 2024; Opesemowo & Ndlovu, 2024) or even limit students' creativity by imposing a rigid framework (Lin & Chen, 2024). Concerns have also been raised about AI's position as the ultimate "epistemic authority," presenting a single truth without evidence of its ability (Cooper, 2023). Therefore, careful consideration of ethical, social, and pedagogical considerations is needed to maximize the benefits of AI while minimizing its risks (AlAli & Wardat, 2024; Mao et al., 2024; Samala et al., 2025).

Facing the opportunities and challenges brought by generative AI, developing AI literacy is a crucial 21st-century skill for learners and educators (Folmeg et al., 2024; Ng et al., 2021). AI literacy includes an understanding of the fundamentals of AI, the ability to use and apply AI tools, disseminate results, and understand ethical issues (Ng et al., 2021). It is important for higher education institutions to systematically introduce and discuss AI literacy in their curricula (Folmeg et al., 2024; Karkoulouian et al., 2024; Maxwell et al., 2025). Furthermore, there is a clear need for

awareness of the potential changes in the function and role of teachers in AI-integrated education, encouraging a collaborative approach rather than just mechanical use (Guan et al., 2025; Mao et al., 2024). The role of educators is shifting to facilitators and collaborators in AI-based learning environments, requiring them to set clear policies, redistribute learning objectives, enhance AI skills, update curricula, and rethink assessment methods (AlAli & Wardat, 2024; Krause et al., 2025; Mulaudzi & Hamilton, 2025). Adequate training and professional development are required for educators to effectively utilize AI tools (AlAli & Wardat, 2024). Ongoing discussions among stakeholders—educators, policymakers, technologists, and students—are essential to navigate the responsible and ethical integration of AI in education, prioritizing human-centered values, equity, and diversity (AlAli & Wardat, 2024; Baidoo-Anu & Owusu Ansah, 2023; Choustoulakis, 2024; Cooper, 2023).

Designing Contextual Mathematics Problems

The role of contextual mathematics problems is a pedagogical practice that connects mathematical concepts to real-world situations or problems, making them relevant and meaningful to students. These problems are not limited to classroom scenarios, but often involve situations that students can experience themselves or real-life contexts that require professional decisions, such as optimization in engineering or problems in agriculture (Sevinc, 2024). The main goal is to move mathematics learning from abstract theory to practical applications that are understandable and helpful to students in contexts that are familiar or relevant to their future. The importance of contextuality also

lies in the ability to develop higher-order mathematical thinking, as emphasized in the development of automated math word problems connected to real-life problems (Hwang & Utami, 2024). While many math problems are presented in a decontextualized scholastic setting, contextual problems integrate the subject of mathematics with the world outside the classroom, increasing student relevance and engagement.

Contextual mathematics problems offer several important benefits in education. These problems not only test conceptual understanding but also effectively engage students in intended mathematical practices, fostering mathematical proficiency (Leavy & Hourigan, 2022). By presenting information that often involves multiple data points and allows for multiple methods and possible answers, contextual problems encourage critical thinking, mathematical reasoning, and the application of knowledge in more complex scenarios (Sevinc, 2024). This approach facilitates the integration of disciplines, such as biology and mathematics, through the practice of mathematical modeling to analyze complex real-world problems (Campillay-Llanos & Cárcamo-Mansilla, 2025). However, designing quality contextual mathematics problems is a challenging task. It requires not only a deep understanding of the mathematical content but also of the chosen context, ensuring that the problems have clarity of language, curricular coherence, appropriate cognitive demands, and allow for multiple solution strategies (Leavy & Hourigan, 2022). These challenges often require high skills and competencies from teachers, including self-confidence in teaching STEM subjects (Sellami et al., 2024) and the ability to adapt to changes in teaching methodology (Haser et al., 2024).

In the face of the complexity of contextual mathematics problem design, artificial intelligence (AI) has emerged as a promising

tool. Generative AI, such as the GPT model, has the potential to help generate authentic mathematics word problems that relate to real-life problems, even with controllable difficulty levels (Hwang & Utami, 2024). Prototype systems have demonstrated the ability of AI to acquire authentic contexts through recognition technology, generate instructional-based prompts, and generate realistic questions with satisfactory linguistic quality information and mathematical validity (Hwang & Utami, 2024). The integration of AI in problem design can support teachers in creating more effective modeling tasks, facilitating the integration of scenarios from fields such as biology into the educational process (Campillay-Llanos & Cárcamo-Mansilla, 2025). Despite significant potential, the implementation and utilization of AI in mathematics education, especially at the elementary level, is heavily influenced by teacher attitudes and the need for targeted professional development to foster positive attitudes and improve teacher proficiency in AI technology (Li, 2025). Therefore, AI can be a valuable tool to facilitate more efficient and relevant question design, but collaboration between artificial intelligence and human pedagogical expertise remains essential to ensure the quality and effectiveness of the questions produced.

The Importance of Agricultural Mathematics Problems for Vocational Schools.

Mathematics is an essential foundation in agriculture and agribusiness, the application of which goes beyond basic calculations. Mathematical skills are essential for professional farmers and individuals engaged in the agricultural sector (Muhrman, 2015). The use of mathematics in agribusiness covers various practical aspects, such as land measurement,

calculation of fertilizer requirements, analysis of crop yields, optimization of agricultural machine efficiency, to financial management of farming businesses (Fatimah & Prabawanto, 2020; Hermans et al., 2024). In Indonesia, the Agricultural Processing Program in Vocational High Schools, which is part of the vocational education spectrum, specifically focuses on the STEAM-H (Science, Technology, Engineering, Agriculture, Mathematics, and Health) field (Fatimah et al., 2023, 2025). This shows the urgent need to integrate disciplines to solve increasingly complex agricultural problems. Vocational education and training (VET) faces significant challenges in equipping individuals for the modern workplace that increasingly demands digital literacy and computational thinking (CT) skills (Hermans et al., 2024). Therefore, the mathematics curriculum in vocational schools must directly support the competencies required in the agricultural industry and prepare students for multifaceted vocational careers.

Designing agricultural-context mathematics problems for vocational high school students is not just an effort to test conceptual understanding, but a crucial strategy to train students in solving real problems that they will face in the world of work. The concepts of agricultural product processing become conceptual and contextual integrators between science and mathematics (Fatimah et al., 2023, 2025), encouraging the application of knowledge in practical scenarios. These problems help bridge the gap between mathematical theory and its application in the field, ensuring the relevance of education to industry demands. In addition, agricultural-context problems support the development of computational thinking (CT) skills that are increasingly important in modern agriculture and in the workplace in general (Chondrogiannis et al., 2021; Hermans et al., 2024). CT, along with the growing demand for

STEM competencies, emphasizes the importance of applying knowledge in the real world and solving problems using new technologies (Chondrogiannis et al., 2021). Thus, agricultural-context mathematics problems equip students with the critical and analytical thinking skills needed to succeed in the ever-growing agricultural sector.

The integration of technology, including AI, into vocational education offers significant opportunities but also brings unique challenges. While AI can significantly improve operational efficiency and resource optimization in the agricultural sector, such as smart irrigation systems that reduce water use and increase crop yields (Hernandez et al., 2024)—its adoption in vocational education faces obstacles such as a lack of infrastructure, the need for specialized technical skills, and social resistance (Hernandez et al., 2024). Additionally, the

integration of AI tools into vocational programs can reduce essential interpersonal interactions and collaborative learning experiences, potentially negatively impacting student retention and the development of critical thinking (Ododo et al., 2024). Studies have shown that many agricultural students still lack adequate mathematical skills for their future professions (Muhрман, 2015), highlighting a gap that AI can address through personalized learning and adaptive feedback. AI therefore offers an opportunity to help teachers create more realistic and interactive learning scenarios, addressing this skills gap. However, to maximize the potential of AI, supportive policies, infrastructure investments, and comprehensive training programs are needed (Hernandez et al., 2024), and clear guidelines and activities that encourage critical thinking and self-directed learning in the use of AI in the classroom (Ododo et al., 2024).

B. METHODS

Research Approach

This study used a mixed methods approach with an exploratory sequential design, where qualitative data was used to deepen understanding of quantitative findings.

Research Participants

In this study, the main participants were 22 6th-semester students of the Mathematics Education Study Program who were taking Applied Mathematics courses. They were directly involved in the AI-assisted math problem design activities. The gender distribution of the participants consisted of four male students and eighteen female students. To provide a more complete picture of the contextual background of the participants on the topic of agriculture, their experiences related to corn planting were also recorded, including the categories of having planted directly, having seen the

planting process, or having no experience at all. Details of the characteristics of the participants can be seen in Table 1.

Table 1: Participant Characteristics

Category Participant		Male	Female
Total Participants		4	18
Experience in Planting Corn	Ever Planted Directly	2	2
	Ever Seen the Planting Process	2	10
	Never (Planted/Seen)	-	6

Mathematics Problem Design Procedure

This study applies a mathematical problem design procedure that involves students in four tiered challenges, designed to observe the use of artificial intelligence (AI) in developing problems with varying levels of context specificity. Each problem designed by students is intended for students of the Food Crops and Horticulture Agribusiness Vocational High School.

In Challenge 1, students have complete freedom to choose mathematical content (including numbers, measurement, algebra, geometry, data analysis, or probability) and integrate it with the general agricultural context. Next, Challenge 2 begins to narrow the focus, where students are still free to choose mathematical content, but the context of the problem must be specific to corn farming. Challenge 3 increases the specificity of the context further, asking students to choose mathematical content and apply it to the context of using corn threshing machine technology. Finally, Challenge 4 is the most demanding, requiring students to create mathematical problems with data analysis content, and still in the context of corn threshing machine technology. This tiered procedure is designed to systematically test students' ability to design problems that are increasingly complex and relevant to the application of mathematics in modern agricultural technology.

Research Instruments

This study used two main instruments to collect data on students' perceptions of the use of generative artificial intelligence (AI) in designing mathematical problems: a questionnaire and a semi-structured interview. The questionnaire was designed to quantitatively measure the frequency of AI use, students' understanding of its limitations and risks, their perceived value of AI (both achievement, intrinsic, and utility values), and perceived costs and intentions of using AI in the future (Chan & Zhou, 2023). To complement and deepen the quantitative data, interviews were conducted to explore students' narratives and experiences, providing a rich qualitative context on how they interact with AI in problem design tasks, challenges faced, strategy verification, and their views on the application of AI to the teaching profession in the future. This combination of instruments aims to produce a comprehensive and holistic understanding. Details of the grid or guidelines for the questionnaire and interview can be seen in Table 2.

Table 2: Research Instruments

Instrument Section	Aspects Measured / Interview Themes	Sample Questionnaire Statements / Key Interview Questions
Questionnaire		
Frequency of Use	The level of use of generative AI in mathematical problem design activities.	How often do you use generative AI technology in your math problem-solving activities?
AI Knowledge	Students' understanding of the limitations and potential risks of generative AI.	I understand that generative AI technology has the potential to produce factually inaccurate output.
Perceived AI Value	Students' perceptions of the benefits and advantages of AI.	I believe that learning to use generative AI technology well will benefit my future career. I feel comfortable using generative AI technology because it does not judge my ideas. I believe that generative AI technology can help me save time in the problem-solving process.
Perceived AI Cost	Students' concerns about the potential negative impacts of AI.	I am concerned that using generative AI technology too often in completing assignments may diminish the value of my university education.
AI Usage Intentions	Students' desire to integrate AI in the future.	I envision integrating generative AI technology into my math problem-solving practice in the future.
Interview		

Specific Uses & Challenges	Ways and types of AI assistance in designing math problems, and the benefits/challenges.	Can you tell us more about how you used this AI in the context of designing a math problem on corn cultivation? What were some of the benefits or challenges you faced?
Understanding	Concrete examples of limitations/risks of AI and strategies for verifying accuracy.	Can you provide a concrete example of how the limitations or risks of generative AI might be relevant in the context of designing math problems? How did you ensure that the information generated by the AI was accurate?
Limitations & Verification	Further explanation of the value of AI for careers and performance, and the impact of AI on the creative process.	How did this influence your creative process in designing problems using AI? Were there any ideas that emerged from interacting with the AI that you might not have thought of before?
Value Reflection & Creative Process	Deep concerns about negative impacts and how to balance the use of AI.	Can you elaborate more on your concerns about the potential reliance on AI in the context of this task? How do you think AI can best be balanced?
Cost Elaboration & Balance	Views on the integration of AI in education and teacher preparation.	What is your vision for how AI can be effectively integrated into mathematics teaching and learning? What additional preparation or skills do you think prospective mathematics teachers need to have?

Data analysis

Data analysis in this study was conducted through quantitative and qualitative approaches. For quantitative data collected through questionnaires from 22 participants, descriptive analysis was conducted to calculate the mean and standard deviation (SD) for each construct. This general analysis aims to provide an overview of participants' perceptions of the use of generative AI in designing mathematical problems. Furthermore, inferential analysis was applied to test hypotheses regarding differences in perceptions and intentions of using generative AI based on demographic characteristics. Independent t-tests were used to compare participant genders, while one-way ANOVA was applied for comparisons based on corn planting experience.

Meanwhile, Qualitative data obtained from interviews with participants were analyzed using a thematic analysis approach. This study focuses on the depth of data and the richness of the narratives obtained, with the hope of achieving thematic saturation on the core issues studied. The thematic analysis process follows the following systematic stages: First, all interview recordings were transcribed

verbatim to ensure the accuracy of the textual data. Second, the researcher conducted an in-depth familiarization with the data through repeated reading of the transcripts to gain a thorough understanding of the content and nuances of the participants' responses. Third, initial coding was carried out inductively, where relevant and interesting text segments were identified and coded. Fourth, similar or related codes were coded to identify broader themes. Fifth, themes that had been reviewed and refined to ensure internal consistency and external differences between themes. Sixth, each theme was given a descriptive name and clearly defined. Finally, qualitative findings are presented in narrative form, supported by direct quotes from participants to illustrate and strengthen the interpretation of the themes found. This approach aims to provide an in-depth contextual understanding of the perceptions and experiences of prospective mathematics teacher students towards the use of generative AI.

Findings

Descriptive analysis was conducted to measure the mean and standard deviation (SD) of each construct identified from the questionnaire (N=22). These results are presented in Table 1,

providing an overview of participants' perceptions of the use of generative AI from the four math problem design challenges given.

Table 3: Descriptive Statistics of Perception of Generative AI Usage

Construct	Item	Average	Standard Deviation	General Interpretation
Frequency of Generative AI Use	Q1	3.23	0,81	Level of use "Sometimes" to "Often".
Understanding Limitations of Generative AI	Q2- Q5	3.42	0,52	Tends to understand how limited AI is
Perceived Value of AI for Career & Competence	Q6-Q8	4.09	0,53	Perceived value of AI is very positive for career development and competence.
Comfort & Benefits of AI in Problem Roles	Q9-Q15	4.09	0,45	Feels very comfortable and sees many benefits of AI in designing questions.
Concerns about AI Use (AI Costs)	Q17-Q20	3.33	0,55	Moderate level of concern.
Intentions for Future AI Integration	Q21-Q22	3.73	0,70	Fairly strong intention to integrate AI in the future.

Overall, students showed a positive attitude towards generative AI technology, particularly in terms of perceived value of AI for career development and academic performance improvement, as well as convenience and usefulness in designing mathematical problems in the context of corn farming. The frequency of AI use was moderate, with a good understanding of the limitations of AI. The level of concern about the negative impacts of AI was moderate, and there was a fairly strong intention to integrate AI into future teaching practices.

Inferential analysis was conducted to test whether there were statistically significant differences in perceptions and intentions of using generative AI based on participant demographic characteristics, namely gender and corn planting experience. Independent t-tests were used for gender comparisons, while one-way ANOVA was used for corn planting experience comparisons. The results of this analysis were consistent across the four datasets collected (first, second, third, and fourth challenges).

Table 4: Comparison of Perception and Intention to Use Generative AI Based on Gender (Independent t-Test)

Construct	Average Male	Average Female	t-value	df	p-value (2-tailed)
Frequency of Generative AI Use	3.25	3.22	0.061	20	0.952
Understanding Limitations of Generative AI	3.31	3.44	-0.365	20	0.719
Perceived Value of AI for Career & Competence	4.00	4.11	-0.279	20	0.783
Comfort & Benefits of AI in Problem Roles	4.00	4.12	-0.589	20	0.562
Concerns about AI Use (AI Costs)	3.19	3.36	-0.428	20	0.673
Intentions for Future AI Integration	3.50	3.78	-0.617	20	0.544

Based on Table 3, the results of the independent t-test show that there is no statistically significant difference ($p > 0.05$) between male and female students on all measured constructs. This indicates that gender does not have a significant influence on the perception and intention of using generative AI in this sample.

Table 5: Comparison of Perception and Intention to Use Generative AI Based on Corn Planting Experience (One-Way ANOVA)

Construct	F-value	df1	df2	p-value
Frequency of Generative AI Use	0.443	2	19	0.648
Understanding Limitations of Generative AI	0.419	2	19	0.664
Perceived Value of AI for Career & Competence	0.000	2	19	1.000
Comfort & Benefits of AI in Problem Roles	0.000	2	19	1.000
Concerns about AI Use (AI Costs)	0.222	2	19	0.803
Intentions for Future AI Integration	0.091	2	19	0.913

Table 5 shows the results of one-way ANOVA analysis, where no statistically significant differences ($p > 0.05$) were found in all constructs based on participants' corn planting experience. This means that their background experience in corn planting does not significantly affect their perception or intention towards generative AI.

In summary, the descriptive findings indicate students' positive tendencies towards generative AI in both academic and problem design contexts. However, inferential analysis consistently revealed that neither gender nor corn growing experience was a statistically significant differentiating factor in the

perception and intention to use generative AI among the study participants. These results need to be interpreted with the relatively small sample size ($N=22$) in mind, which may limit the statistical power to detect more subtle differences.

To complement and deepen the understanding of the quantitative findings, a qualitative analysis was conducted through interviews with participants. The main findings of this thematic analysis, summarizing the perceptions and intentions of pre-service mathematics teachers towards the use of generative AI, are presented visually in Figure 1.

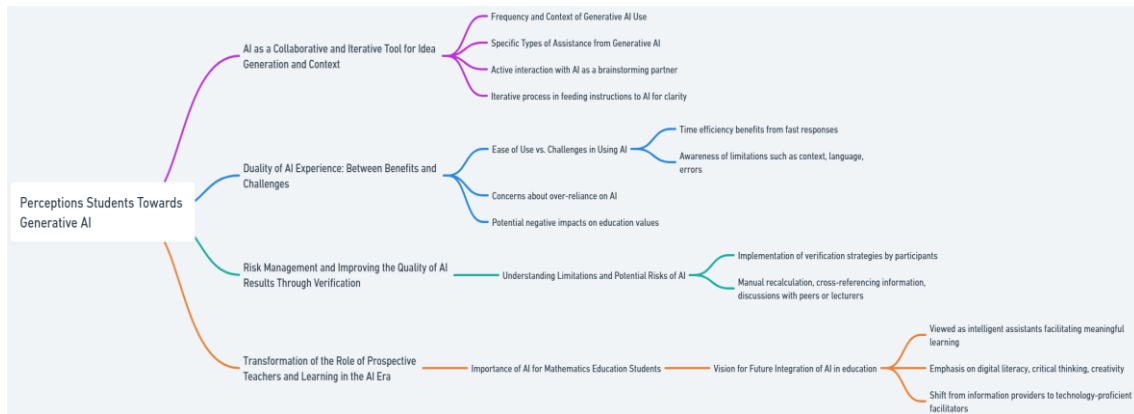


Figure 1: Student Perceptions of the Use of AI in Designing Mathematics Problems (Thematic Analysis Based on Interviews)

The results of the thematic analysis consistently highlighted the use of generative AI as an iterative and collaborative tool in designing mathematical problems in the context of corn cultivation. Actively participating in using AI to "figure out the context, content, and mathematical concepts that I want to include in the problem", and identifying initial ideas and contexts for the problem. AI was seen as a "reliable brainstorming partner" that was efficient and generated "new ideas that I had not thought of before". They also stated the ease of using AI because it was "very fast in responding" and "very efficient in terms of time spent on tasks". This process often involved iterative adjustments to the prompts: "If the answer felt lacking, I would input instructions into the AI to make it clearer what I meant". In addition, AI was also able to provide "information about the grower, which helped me in contextualizing the problem", demonstrating its ability to provide new insights.

However, interviews also revealed some challenges and concerns that were consistent with the quantitative findings. Participants noted that the AI-generated questions were sometimes "less contextual/realistic" and used "too formal or stiff language". They further explained that "sometimes the AI doesn't understand what we are asking it to do, or the

explanations are not relevant", which required participants to "explain in detail what we need the AI to do in order to produce the appropriate results". Key concerns referred to the potential for "logical or mathematical errors" that AI could make, as well as the potential for "over-reliance on AI" that could "undermine core values of education" and reduce "interaction and socialization with peers or lecturers".

To overcome these obstacles and concerns, participants proactively implemented verification strategies. They "recalculated manually or calculated by themselves", "searched widely for information" from other sources, and "discussed it with lecturers or friends". Participants also emphasized the importance of "not just copying and pasting from AI" and "not being completely sure that all the answers given by AI are correct". Their vision for the future of AI in education is as an "intelligent assistant for teachers and students" that can free teachers from administrative tasks to focus on meaningful interactions, and be a "catalyst" for creating "more contextual, relevant, and meaningful learning". Therefore, participants emphasized the importance of prospective mathematics teachers having "digital literacy", "critical thinking skills", "creativity", and the ability to "continue to learn and adapt to technological

developments” in order to utilize AI optimally and responsibly.

C. DISCUSSION

This study aims to analyze the perceptions and intentions of prospective mathematics teacher students towards the use of generative AI in designing mathematics problems in the context of corn cultivation, using quantitative and qualitative approaches. The main results of the study reveal a multifaceted picture of the adoption and acceptance of AI technology in the context of mathematics education.

Quantitatively, the findings show that participants have a very positive perception of AI for career development and digital competence, and feel comfortable and have many benefits in using it to design questions. This is indicated by the high average for these constructs (Average = 4.09 for both constructs). The intention to integrate AI in the future is also relatively strong (Average = 3.73). This dominant positive perception is in line with various recent studies that indicate a generally positive view of generative AI in education (Chan & Lee, 2023; Nyaaba Akanzire et al., 2023), where students' intention to use it for learning is greatly influenced by their perceived value and AI literacy (Al-Abdullatif & Alsubaie, 2024). Participants widely recognized the potential of AI in increasing productivity, efficiency, and personalized learning. However, the moderate tendency to adopt AI (Mean = 3.23) suggests that despite high interest, full adoption may still be in its infancy or dependent on the specific task context, or even limited knowledge of the AI concept itself. Furthermore, inferential analyses consistently showed no significant differences in perceptions and intentions of adopting AI based on participants' gender or corn growing experience ($p > 0.05$ for all constructs). This finding contrasts with several studies that have shown variation based on demographics, such

as higher attitudes and self-efficacy among male teachers in STEM contexts (Al Darayseh & Mersin, 2025). This may indicate that interest and views toward generative AI transcend gender demographics or specific practical experience in this context, or may be influenced by the relatively small sample size ($N = 22$) that failed to detect more subtle differences.

The qualitative analysis results provide a deeper layer of understanding to the quantitative findings, explaining the “how” and “why” behind these perceptions. Interviews revealed that participants viewed AI as a collaborative and iterative tool for idea generation. They used AI to “figure out context, content, and mathematical concepts” and as an efficient, reliable brainstorming partner.” The iterative process, such as “if I feel the answer is not enough, I will give instructions to the AI to make it clearer what I mean,” confirms that the use of AI is not a one-way process, but rather a dynamic interaction to refine the results. This observation is consistent with research exploring human-AI collaboration in creative and analytical tasks, where AI can improve the efficiency of coding and data exploration (Yan et al., 2024), as well as supporting a three-stage iterative process in a human-dominated pre-writing task (Wan et al., 2024). In line with the concept of human-in-the-loop AI, where the human role remains crucial in guiding and validating AI output (Gao et al., 2024; Lawton et al., 2023).

On the other hand, qualitative findings also shed light on the challenges and concerns identified quantitatively. Participants experienced AI output that was “less contextual/less realistic” and sometimes “didn't understand what we were asking,” requiring very detailed prompts. Significant concerns were raised regarding the potential for “logical or mathematical errors” and the risk of “over-reliance on AI” that could

“undermine core values of education.” These concerns are consistent with broader discussions in the literature on the ethics of AI in education, such as issues of accuracy, bias (Adel et al., 2024), plagiarism, stifled creativity, and erosion of originality (Khatri & Karki, 2023), as well as the negative impacts on students’ critical thinking, decision-making, and analytical reasoning skills due to over-reliance on AI (Zhai et al., 2024).

In response to these challenges and concerns, participants proactively developed verification strategies. They not only “recalculated manually” and “searched widely” from other sources, but also “discussed it with lecturers or friends”. This strategy emphasizes the importance of AI literacy and critical thinking, where prospective teachers do not “just copy and paste from AI” and “do not fully believe all the answers AI provides are correct”, in line with the crucial skills identified for educators to navigate this technological landscape effectively (Alexandrowicz, 2024; Ismail et al., 2024). This emphasizes a paradigm shift from passive information consumption to a role in activating and adapting AI output, in line with the 21st-century digital competency framework and the need for a shift in teacher preparation amidst the integration of AI in education (Alexandrowicz, 2024; Walter, 2024a). In this context, the development of validated problem-based questions to enhance critical thinking skills becomes highly relevant in teacher education curricula to prepare future educators to face AI challenges, while fostering understanding of AI concepts, ethical considerations, and contextual applications through a critical co-discovery approach (Dilek et al., 2025; Walter, 2024a).

This study offers some important ideas for teacher development in the AI era. Mathematics education curricula need to integrate modules on the responsible use of generative AI, including training in prompt

engineering, critical evaluation of AI outputs, and ethical use of AI. This integration of AI literacy and critical thinking skills development is crucial to preparing future educators (Walter, 2024b). In line with this, continuing professional development programs for mathematics teachers should be emphasized to ensure they have essential “digital literacy” and “critical thinking skills,” given that generative AI can improve pre-service teachers’ problem-posing skills and TPACK (Biton & Segal, 2025), as well as enhance their self-efficacy and higher-order thinking skills (Lu et al., 2024). Participants’ vision of AI as an “intelligent assistant for teachers and students” that can free teachers from administrative tasks to focus on meaningful interactions (Walter, 2024b) and act as a “catalyst” for creating “more contextual, relevant, and meaningful learning” provides clear direction for pedagogical innovation, including the potential for AI to assist with problem solving, tutoring, task adaptation, and lesson planning (Walkington, 2025). The originality and novelty of this study lie specifically in exploring preservice mathematics teacher students’ perceptions and intentions of using generative AI in the specific context of designing corn cultivation problems, an area that is rarely addressed in the existing literature. Furthermore, the mixed-methods approach that deeply integrates quantitative and qualitative data provides a comprehensive understanding of not only “what” participants perceive, but also “why” and “how” they interact with AI. This allows researchers to capture the complex nuances of human-AI interactions in educational settings, particularly from the perspective of aspiring educators who will shape the next generation, while filling gaps in the literature with first-hand insights from key groups who will integrate these technologies in the classroom.

D. CONCLUSION

This study examines the perceptions and intentions of prospective mathematics teacher students towards the use of generative AI in designing problems in the context of corn cultivation through a mixed approach. The results consistently show that participants have very positive perceptions of the value of AI for career development and competence, and feel significant benefits and comfort in using it to design mathematical problems. Although the frequency of use is still moderate, there is a strong intention to integrate AI in the future, an understanding of its limitations. Further quantitative analysis found no significant differences in these perceptions and intentions based on gender or corn cultivation experience. Qualitatively, AI is seen as an efficient collaborative, and iterative tool for generating ideas and problem contexts, but participants are also very aware of challenges such as a lack of contextualization, rigid language, and potential AI logic errors, as well as the risk of dependency. This awareness drives them to proactively implement verification and validation strategies. Their vision of AI in the future is as an intelligent assistant that facilitates meaningful learning, requiring teachers to have high digital literacy, critical thinking skills, creativity, and adaptability.

The implications of this study are highly relevant for teacher development, highlighting the urgency of integrating modules on responsible use of generative AI—including prompt engineering and critical evaluation—and AI ethics into mathematics education curricula. Furthermore, continuing professional development programs are essential to equip teachers with the digital literacy and critical thinking skills needed in the AI era. However, this study has limitations, particularly in the quantitative sample size (N=22), which limits the generalizability of the findings and the ability to detect more subtle

differences. Therefore, future research is recommended to involve larger and more diverse samples, longitudinal studies to observe the evolution of perceptions, and intervention studies to test the effectiveness of AI training programs in improving pre-service teachers' competencies.

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