ENHANCING PEDAGOGICAL SKILLS OF PROSPECTIVE MATHEMATICS TEACHERS THROUGH CHATGPT AI INTEGRATION

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Abstract

The integration of artificial intelligence (AI) in education has brought significant changes in teaching methods, especially in improving the pedagogical skills of prospective teachers. However, there is still a gap in understanding how AI, especially ChatGPT AI, can effectively support the development of creative teaching skills in mathematics education. This study aims to explore the role of ChatGPT AI in improving the teaching skills of prospective mathematics teachers, focusing on the planning, implementation, and evaluation of learning. Using a descriptive-analytical research design, data were collected from 47 prospective mathematics teachers through structured interview cards with a Likert scale. The results showed that the integration of AI significantly improved fluency in lesson planning. However, there were still challenges in flexibility and originality during the implementation and evaluation process of learning. This study emphasizes the need for additional training in AI-based pedagogy to improve adaptation and innovation in teaching practices. The findings suggest that structured AI integration can bridge the gap between pedagogical theory and classroom practice, thereby contributing to improving the effectiveness of mathematics learning.

Keywords: *Artificial Intelligent, Creative Teaching, ChatGPT, Math, Pedagogical Skills.*

مستخلص البحث

أدى دمج الذكاء الاصطناعي في التعليم إلى إحداث تغييرات كبيرة في طرق التدريس، لا سيما في تحسين المهارات التربوية للمعلمين المحتملين. ومع ذلك، لا تزال هناك فجوة في فهم كيف يمكن للذكاء الاصطناعي، وخاصة الذكاء الاصطناعي في ChatGPT، أن يدعم بشكل فعال تطوير مهارات التدريس الإبداعية في تعليم الرياضيات. هدف هذا البحث إلى استكشاف دور الذكاء الاصطناعي ChatGPT في تحسين مهارات التدريس لدى معلمي الرياضيات المحتملين، مع التركيز على تخطيط التعلم وتنفيذه وتقييمه. باستخدام تصميم بحثي وصفي تحليلي، تم جمع البيانات من ٤٧ معلم رياضيات محتمل من خلال بطاقات مقابلات منظمة بمقياس ليكرت. أظهرت النتائج أن دمج الذكاء الاصطناعي حسّن بشكل كبير من الطلاقة في تخطيط الدروس. ومع ذلك، كانت لا تزال هناك تحديات في المرونة والأصالة أثناء عملية التنفيذ والتقييم للتعلم. أكّد هذا البحث على الحاجة إلى تدريب إضافي في التربية القائمة على الذكاء الاصطناعي لتحسين التكيف والابتكار في ممارسات التدريس. تشير النتائج إلى أن التكامل المنظم للذكاء الاصطناعي يمكن أن يسد الفجوة بين النظرية التربوية والممارسة الصفية، مما يسهم في تحسين فعالية تعلم الرياضيات.

الكلمات المفتاحية: *الذكاء الاصطناعي والتدريس الإبداعي وChatGPT والرياضيات والمهارات التربوية.*

INTRODUCTION

In education, particularly in Mathematics learning, there is a significant gap between the ideal pedagogical theories taught in teacher training programs and the teaching practices implemented in the field. Pedagogical theories emphasize the importance of creative approaches to learning to improve students' understanding of concepts, emphasizing problem-based, collaborative, and project-based learning methods designed to stimulate critical thinking and problem-solving skills.[1] However, reality shows that many prospective Maths teachers still face challenges implementing these creative and innovative teaching methods. Factors such as limited access to interactive learning resources, including cutting-edge educational technology, and a lack of ongoing training focused on developing pedagogical skills are major barriers to prospective teachers adopting these approaches effectively.[2]

In addition, high workloads and a lack of professional support in the school environment often lead prospective teachers to fall back on traditional teaching methods that they feel are more secure and tested, even though they may be less effective in facilitating active and participatory learning.[3] This situation creates a noticeable gap between theory and practice, where prospective teachers are equipped with rich theoretical knowledge but often do not get enough opportunities to practice it effectively in real teaching contexts. As a result, they may experience difficulties adapting these theories to the needs and realities of diverse and dynamic classrooms.[4]

This gap raises the pressing question of how technology, particularly Artificial Intelligence (AI), can be utilized to bridge this gap and improve the pedagogical skills of prospective teachers. AI has the potential to provide adaptive and personalized tools in the learning and teaching process, which can support teacher candidates in designing and implementing more creative teaching approaches. By providing access to personalized course materials, real-time feedback, and data

[1] Garry Falloon, "Investigating Pedagogical, Technological and School Factors Underpinning Effective 'Critical Thinking Curricula' in K-6 Education", *Thinking Skills and Creativity* 51 (March 1, 2024): 101447, https://doi.org/10.1016/J.TSC.2023.101447; Le Thanh Thao et al., "Optimal Pedagogical Strategies in Research Methodology: Insights from Student Experiences", *Volume 9, Issue 4* 9, no. 4 (January 1, 2024), https://doi.org/10.54517/esp.v9i4.2342.

[2] Paola Andrea Arciniegas García et al., "Identification of Areas for Improvement in Digital Pedagogical Competencies through Information Technologies, Communication, and Artificial Intelligence: An Innovative Approach in Teacher Training", *Volume 15347 LNCS, Pages 476 - 487* 15347 LNCS (2025): Valencia, https://doi.org/10.1007/978-3-031-77738-7_39.

[3] Christine Lotter et al., "Challenges and Supports for Secondary Science and Mathematics Teacher Retention", *Volume 124, Issue 5, Pages 307 - 322*, October 1, 2024, https://doi.org/10.1111/ssm.12647.

[4] Esther Gheyssens et al., "Differentiated Instruction: The Diversity of Teachers' Philosophy and Praxis to Adapt Teaching to Students' Interests, Readiness and Learning Profiles", *International Journal of Inclusive Education* 26, no. 14 (2022): 1383–1400, https://doi.org/10.1080/13603116.2020.1812739; Matthijs Koopmans, "Education Is a Complex Dynamical System: Challenges for Research", *The Journal of Experimental Education* 88, no. 3 (May 1, 2020): 358–74, https://doi.org/10.1080/00220973.2019.1566199.

analysis, AI can help prospective Mathematics teachers more effectively evaluate students' learning needs and adapt their teaching strategies more appropriately.[5]

Several previous studies have examined the use of technology in education, including the application of AI in teaching. For example, a study by showed that integrating AI in the classroom could improve learning efficiency and personalization. However, the study focused more on students rather than the development of teachers' teaching skills. Another study by[6] highlighted the potential of AI in supporting teachers' professional development, but few discussed its use in the context of prospective Maths teachers. This research aims to fill that gap by examining how ChatGPT AI can enhance the pedagogical skills of prospective Maths teachers.

This study focuses on integrating AI technologies with the development of prospective Maths teachers' pedagogical skills, significantly contributing to the limited literature on the use of AI in teacher education. Unlike previous research that has focussed on student learning outcomes or the use of AI in classroom management,[7] this study explores how AI ChatGPT can support the creative aspects of teaching, encompassing lesson planning, implementation, and evaluation. By highlighting the role of AI in facilitating and enhancing teaching creativity, this study adds a new dimension to the utilization of educational technology that places more emphasis on the professional development of prospective teachers.

ChatGPT AI can analyze learning data and provide personalized feedback and can be an important tool for aspiring teachers in developing and refining innovative lesson plans. The study by[8] showed that AI can help teachers identify more effective teaching approaches based on students' learning patterns, which can be adapted to enhance creativity in teaching. In addition, AI can support pre-service teachers in teaching implementation by providing simulated classroom scenarios that allow them to practice and develop teaching skills without the pressure of a real environment.[9]

[5] Dabae Lee and Sheunghyun Yeo, "Developing an AI-Based Chatbot for Practicing Responsive Teaching in Mathematics", *Computers & Education* 191 (December 1, 2022): 104646, https://doi.org/10.1016/J.COMPEDU.2022.104646.

[6] Lee and Yeo, "Developing an AI-Based Chatbot for Practicing Responsive Teaching in Mathematics".

[7] Wayne Holmes et al., "Ethics of AI in Education: Towards a Community-Wide Framework," *International Journal of Artificial Intelligence in Education* 32, no. 3 (September 1, 2022): 504–26, https://doi.org/10.1007/S40593-021-00239-1/FIGURES/1.

[8] Beng Huat See et al., "Is Technology Always Helpful?: A Critical Review of the Impact on Learning Outcomes of Education Technology in Supporting Formative Assessment in Schools", *Research Papers in Education* 37, no. 6 (November 2, 2022): 1064–96, https://doi.org/10.1080/02671522.2021.1907778.

[9] Huiying Cai et al., "Exploring Pre-Service Teachers' Reflection Mediated by an AI-Powered Teacher Dashboard in Video-Based Professional Learning: A Pilot Study", *Educational Technology Research and Development*, December 5, 2024, 1–26, https://doi.org/10.1007/S11423-024-10442-1/METRICS.

This research also assesses how AI can assist prospective teachers in developing the skills of fluency, flexibility, and originality in their teaching process. Fluency in this context refers to the ability to generate many ideas or solutions in teaching, while flexibility reflects the ability to adapt to different situations and diverse student needs. Originality, on the other hand, emphasizes originality and innovation in teaching approaches. The study by[10] highlights how AI can facilitate the development of these skills by providing a dynamic and adaptive learning environment where prospective teachers can experiment with different teaching methods and get immediate feedback for improvement.

This study aims to answer several key questions: How can ChatGPT AI improve the pedagogical skills of prospective Maths teachers? What aspects of creative skills are most affected by using ChatGPT AI in teaching? How can prospective Maths teachers utilize this technology to design, implement, and evaluate more effective and innovative learning? As a provisional answer to these questions, this research argues that the use of ChatGPT AI can significantly improve the pedagogical skills of prospective Maths teachers by providing tools that support more creative and adaptive teaching. Preliminary evidence suggests that AI can assist in constructing more engaging lesson materials, provide more immediate and personalized feedback, and support the development of fluency and flexibility skills in teaching. Therefore, this study aims to test the hypothesis that integrating ChatGPT AI in teacher training can positively impact their readiness to teach Mathematics creatively and effectively.

AI Model in Maths Learning

The use of Artificial Intelligence (AI) models in learning Mathematics has been a growing research topic in recent years. Recent studies have shown that AI has great potential to improve student learning outcomes by providing a more personalized and adaptive learning experience. According to research by,[11] implementing AI in Mathematics teaching can assist in analyzing individual students' learning difficulties and provide tailored recommendations, thus accelerating the learning process. AI has also been shown to increase student engagement through interactive and engaging presentation of learning materials, which in turn can improve their conceptual understanding.[12]

[10] Gligorea et al., "Adaptive Learning Using Artificial Intelligence in E-Learning: A Literature Review".

[11] Mao Li, "Integrating Artificial Intelligence in Primary Mathematics Education: Investigating Internal and External Influences on Teacher Adoption"," *International Journal of Science and Mathematics Education*, October 24, 2024, 1–26, https://doi.org/10.1007/S10763-024-10515-W/TABLES/8.

[12] Aymane Ezzaim et al., "AI-Based Learning Style Detection in Adaptive Learning Systems: A Systematic Literature Review", *Journal of Computers in Education 2024*, June 27, 2024, 1–39, https://doi.org/10.1007/S40692-024-00328-9.

In addition, AI enables the automation of teachers' administrative tasks, such as grading assignments and drafting reports, which gives teachers more time to focus on direct interactions with students.[13] Another study by[14] showed that AI could detect student behavior patterns that may indicate confusion or boredom so that teachers can immediately provide appropriate interventions. AI models also help provide instant and accurate feedback, which is important in maths learning as students need immediate confirmation to understand whether they have solved the problem correctly or need to refine their approach.

However, while these benefits are significant, some challenges need to be addressed, including student data privacy issues and the need for seamless integration of technology in the curriculum.[15] In recent years, various Artificial Intelligence (AI) based applications have been developed to support the learning of Maths. These applications are designed to assist students in understanding complex concepts through a more personalized and interactive approach. One popular application is ALEKS (Assessment and Learning in Knowledge Spaces), which uses AI models to identify students' weaknesses in Maths and provide tailored learning materials.[16] By providing adaptive assessment, ALEKS allows students to learn at their own pace and ensure that they understand each concept before moving on to the next stage.

Other apps, such as DreamBox Learning, use AI to personalize Maths learning by providing instant feedback and adjusting learning paths based on student responses.[17] DreamBox also offers educational games to increase student engagement and make learning Maths fun. In addition, Photomath is an app that uses AI-based image recognition to help students solve math problems

[13] Petros Lameras and Sylvester Arnab, "Power to the Teachers: An Exploratory Review on Artificial Intelligence in Education", *Information 2022, Vol. 13, Page 14* 13, no. 1 (December 29, 2021): 14, https://doi.org/10.3390/INFO13010014.

[14] Angel Olider Rojas Vistorte et al., "Integrating Artificial Intelligence to Assess Emotions in Learning Environments: A Systematic Literature Review", *Frontiers in Psychology* 15 (June 19, 2024): 1387089, https://doi.org/10.3389/FPSYG.2024.1387089/BIBTEX.

[15] Yanzhi Zhao, Mingsi Zhao, and Fengyu Shi, "Integrating Moral Education and Educational Information Technology: A Strategic Approach to Enhance Rural Teacher Training in Universities", *Journal of the Knowledge Economy* 15, no. 3 (December 28, 2023): 15053–93, https://doi.org/10.1007/S13132-023-01693-Z/METRICS.

[16] Hoda Harati et al., "Assessment and Learning in Knowledge Spaces (ALEKS) Adaptive System Impact on Students' Perception and Self-Regulated Learning Skills", *Education Sciences 2021, Vol. 11, Page 603* 11, no. 10 (October 1, 2021): 603, https://doi.org/10.3390/EDUCSCI11100603; Tristan Kumor et al., "ALEKS in High School Mathematics Classrooms: Exploring Teachers' Perceptions and Use of This Tool", *TechTrends 2024 68:3* 68, no. 3 (May 4, 2024): 506–19, https://doi.org/10.1007/S11528-024-00955-0.

[17] Georgiois Vasileios Polydoros, "Harnessing AI and Digital Tools for Micro-Credentialing in Mathematics Education: Enhancing Learning Outcomes for Students with Learning Difficulties", January 1, 2025, 195–216, https://doi.org/10.4018/979-8-3693-5488-9.CH009; S Das and S Anowar, "Intelligence and Artificial Intelligence: Core Concepts, Interrelationships, and Educational Possibilities", 2024, https://www.researchgate.net/profile/Saeed-Anowar-4/publication/385902413_Intelligence_and_Artificial_Intelligence_Core_Concepts_Interrelationships_and_Educational_Possibilities/links/673ae3a7f255d5728674acf4/Intelligence-and-Artificial-Intelligence-Core-Concepts-Interrelationships-and-Educational-Possibilities.pdf.

by simply taking a picture of the problem. Photomath not only provides the answer but also displays the steps of the solution, which can help students understand the process behind the solution.[18] Microsoft Math Solver is another example of an AI application that supports learning Maths. It uses handwriting recognition to solve math problems, ranging from algebra to calculus. Microsoft Math Solver offers step-by-step explanations and additional resources, such as video tutorials and articles, to support student learning.[19]

One of the main advantages of ChatGPT is its accessibility, allowing students to study anytime and from anywhere, supporting flexibility in their learning schedule. ChatGPT can also customize responses based on students' needs, providing a more personalized learning experience.[20] Furthermore, with its interactive capabilities, ChatGPT increases student engagement, encouraging them to be more active in learning.[21] ChatGPT can serve many students simultaneously, making it a scalable solution for mass learning. However, ChatGPT is not free from drawbacks. One of them is its limitation in understanding very specific contexts or nuances in complex conversations, which may affect the accuracy of the answers.[22] In addition, reliance on rehearsal data can lead to bias or misinformation if the data is not representative.[23] ChatGPT also lacks critical thinking skills, which are important in education to help students develop in-depth analysis and ethical understanding.[24] There is also a risk of students' over-reliance on ChatGPT, which may hinder their critical and independent thinking development.[25] Further research is needed

[18] S Orhani and Besim Çeko, "Mobile Applications as Aids for Solving Systems of Linear Equations with Two Variables Using the Graphical Method", *International Research Journal of Science, Technology, Education, and Management*, 2024, https://www.academia.edu/download/117158913/IRJSTEM_V4N2_2024_P02.pdf.

[19] Mona A. A. Mohamed et al., "Applications of Artificial Intelligence in Teaching Mathematics for the Second Preparation Year in Egyptian Official Language Schools", *البحوث التطبيقية في العلوم والانسانيات* 1, no. 1 (July 1, 2024): 77–94, https://doi.org/10.21608/AASH.2024.368292.

[20] Fernando Antonio Flores Limo et al., "Personalized Tutoring: ChatGPT as a Virtual Tutor for Personalized Learning Experiences", *Przestrzeń Społeczna (Social Space)* 23, no. 1 (June 2, 2023): 293–312, https://socialspacejournal.eu/menu-script/index.php/ssj/article/view/176.

[21] Anissa M. Bettayeb et al., "Exploring the Impact of ChatGPT: Conversational AI in Education", *Frontiers in Education* 9 (July 4, 2024), https://doi.org/10.3389/feduc.2024.1379796.

[22] Arun James Thirunavukarasu et al., "Trialling a Large Language Model (ChatGPT) in General Practice with the Applied Knowledge Test: Observational Study Demonstrating Opportunities and Limitations in Primary Care", *JMIR Medical Education* 9, no. 1 (April 21, 2023): e46599, https://doi.org/10.2196/46599; Mohd Azman Abas et al., "ChatGPT and Personalized Learning: Opportunities and Challenges in Higher Education", *International Journal of Academic Research in Business and Social Sciences,* vol. 13, no. 12 (December 17, 2023), https://doi.org/10.6007/IJARBSS/v13-i12/20240.

[23] Siraprapa Chavanayarn, "Navigating Ethical Complexities Through Epistemological Analysis of ChatGPT", *Bulletin of Science, Technology & Society,* vol. 43, no. 3–4 (December 21, 2023): 105–14, https://doi.org/10.1177/02704676231216355.

[24] Darwin et al., "Critical Thinking in the AI Era: An Exploration of EFL Students' Perceptions, Benefits, and Limitations", *Cogent Education,* vol. 11, no. 1 (December 31, 2024): 2290342, https://doi.org/10.1080/2331186X.2023.2290342.

[25] Ana Filipa and Andrade Da Silva, "Critical Thinking and Artificial Intelligence in Education", n.d., accessed February 7, 2025.

to understand its potential and limitations properly. How ChatGPT is evolving and how it will affect the world of education.

Creative Teaching Skills

Creative teaching skills are the capacity of teachers to design, implement, and evaluate learning that conveys knowledge and encourages critical thinking, problem-solving, and innovation among students. In modern education, creativity in teaching is essential to meet the challenges of 21st-century learning, where students must be able to adapt to rapid changes in technology and information. This ability includes implementing innovative strategies that inspire students to explore new ideas and develop real-world relevant skills.

Several key characteristics characterize creative teaching. Firstly, flexibility refers to the teacher's ability to adapt teaching methods according to the needs and potential of students and the dynamic classroom situation.[26] Second is fluency, which is the ability to generate many diverse ideas or solutions in the learning process.[27] Third, originality shows the ability to create unique and original ideas or methods in the context of teaching.[28] Fourth, openness to new experiences allows teachers to continue learning and implementing the latest innovations in their learning.

Creative teaching skills can be classified into three main categories: planning, implementation, and evaluation. In planning, teachers should be able to design curriculum and lesson plans that encourage student engagement and active learning.[29] At the implementation stage, creative skills involve using various teaching methods, such as project-based learning, interactive technology, and collaborative approaches that motivate students to participate actively.[30] Finally, in evaluation, creative skills include developing innovative assessment tools to measure knowledge and students' critical and creative thinking skills.[31] Developing creative teaching skills among teachers is key to creating a learning environment that supports innovation and 21st century skills.

[26] Hussein Meihami, "An Exploratory Investigation into EFL Teacher Educators' Approaches to Develop EFL Teachers' Ability to Teach for Creativity," *Thinking Skills and Creativity* 43 (March 1, 2022): 101006, https://doi.org/10.1016/J.TSC.2022.101006.

[27] Luki Emiliya Hidayat, Yazid Basthomi, and Rida Afrilyasanti, "Exploring Secondary School Teachers' Creativity in Differentiated Instruction (DI) Practices across Indonesian EFL Classrooms," *Thinking Skills and Creativity* 53 (September 1, 2024): 101620, https://doi.org/10.1016/J.TSC.2024.101620.

[28] Teresa Cremin and Kerry Chappell, "Creative Pedagogies: A Systematic Review," *Research Papers in Education* 36, no. 3 (May 4, 2021): 299–331, https://doi.org/10.1080/02671522.2019.1677757.

[29] James C. Kaufman and Ronald A. Beghetto, "Beyond Big and Little: The Four C Model of Creativity," *Review of General Psychology* 13, no. 1 (March 1, 2009): 1–12, https://doi.org/10.1037/a0013688.

[30] Hao Yu, "Enhancing Creative Cognition through Project-Based Learning: An In-Depth Scholarly Exploration," *Heliyon* 10, no. 6 (March 30, 2024), https://doi.org/10.1016/J.HELIYON.2024.E27706.

[31] W Christopher Brandt, "Measuring Student Success Skills: A Review of the Literature on Creative Thinking.," *National Center for the Improvement of Educational Assessment*, December 2023, www.nciea.org.

Research shows that teachers who can integrate creativity into teaching tend to be more effective in improving student engagement and achievement.[32]

METHOD

This study used a descriptive analysis approach to explore how the use of ChatGPT AI can improve the pedagogical skills of prospective Mathematics teachers. This design allowed the researcher to describe and analyze the data collected mathematically to identify relevant patterns related to implementing AI technology in teaching. Through this approach, the research aims to provide in-depth insight into the effectiveness of ChatGPT AI in supporting prospective teachers in planning, implementing, and evaluating creative learning.

This research was conducted at Institut Ahmad Dahlan Probolinggo, with the participation of prospective Maths teachers. This location was chosen as it provides direct access to prospective teachers in professional training, enabling the collection of relevant data regarding the use of AI technology in developing their pedagogical skills. This research instrument consists of two main components: (1) A closed-ended interview card, was used to evaluate prospective secondary school Maths teachers' inventive teaching methods and teaching skills. The card was designed with questions that measured the frequency of using creative approaches in teaching. (2) The teacher instruction card, contains procedures for enabling and using the ChatGPT AI model in teaching. These instructions are designed to assist prospective teachers in understanding and applying AI as a tool in their teaching process.

The first thing to do was to compile the interview cards. The interview cards contained creative teaching skills to be applied to prospective Maths teachers. They were created based on the data collected related to the research objectives, theoretical literature related to the research topic, and experts' opinions. These interview cards were created in 3 categories of creative teaching skills: planning, implementation, and evaluation. The statements were arranged on a Likert scale of 1 (never) to 4 (often) to assess how often prospective teachers apply creative teaching methods.[33] Secondly, creating instruction cards used to activate the ChatGPT AI model in developing the creative teaching skills of prospective Mathematics teachers. The conceptualization for activating the ChatGPT AI model in developing the creative teaching skills of prospective Mathematics teachers is based on several points: premises and determinants of the proposed concept, objectives,

[32] Wenjuan Li, "On the Role of Creativity in the Application-Oriented University Students' Engagement and Success," *Heliyon,* vol. 9, no. 6 (June 1, 2023), https://doi.org/10.1016/J.HELIYON.2023.E17374.

[33] Mary R. Lynn, "Determination and Quantification of Content Validity," *Nursing Research,* vol. 35, no. 6 (November 1986): 382???386, https://doi.org/10.1097/00006199-198611000-00017.

reference sources, contents of the proposed concept, importance of the ChatGPT AI model, mechanisms for activating ChatGPT AI, requirements for implementing the ChatGPT AI model, and suggestions. Furthermore, the research instrument was validated by five experts in curriculum and teaching methods to ensure the validity and reliability of the questions used. After the experts returned the form, the instrument was statistically analyzed by a content validity index (CVI). The Item-Content Validity Index (I-CVI) can range from 0 to 1. If the I-CVI is greater than 0.79, the item is considered relevant. If it falls between 0.70 and 0.79, the item requires revisions. An item with an I-CVI value below 0.70 was eliminated. When there are more than five experts, an I-CVI value of 0.78 is considered acceptable.[34] The Scale-Content Validity Index (S-CVI) indicates the average score of the overall content validity scale. An S-CVI value of 0.8 or higher is generally acceptable (Polit).

RESULTS AND DISCUSSION

Prospective Maths Teachers Should Have Access to Innovative and Creative Teaching Techniques

Creative teaching ability is essential in improving the learning process's effectiveness. It includes skills such as fluency in generating innovative ideas, flexibility in adapting teaching methods according to students' needs, originality in creating unique approaches, attention to detail in lesson planning and implementation, and sensitivity to problems that enable teachers to recognize and overcome student challenges. Teachers with this ability can create an informative learning environment that motivates students to think critically and creatively.

Previous research has identified the importance of creative teaching skills in modern education. Runco (2020) pointed out that creative teachers can design engaging lessons and encourage exploring new ideas, increasing student engagement. Creative teaching approaches positively correlate with students' motivation, which is an important factor in their academic success. In addition,[35] highlighted that creativity in teaching allows teachers to be more effective in meeting students' individual needs, especially in heterogeneous classrooms, which include diverse backgrounds and learning abilities.

This study shows that access to innovative and creative teaching techniques is essential for prospective Maths teachers. The results of the data analysis revealed that prospective teachers with

[34] Lynn.

[35] Dan Davies et al., "The Roles and Development Needs of Teachers to Promote Creativity: A Systematic Review of Literature," *Teaching and Teacher Education* 41 (July 1, 2014): 34–41, https://doi.org/10.1016/J.TATE.2014.03.003; Giselle B. Esquivel, "Teacher Behaviors That Foster Creativity," *Educational Psychology Review* , vol. 7, no. 2 (June 1995): 185–202, https://doi.org/10.1007/BF02212493/METRICS.

creative thinking skills in teaching mathematics can design, implement, and evaluate learning that is more effective and interesting for students. These creative thinking skills enable them to adapt teaching to the needs of diverse students, create a more dynamic learning environment, and improve students' understanding of Mathematics concepts.

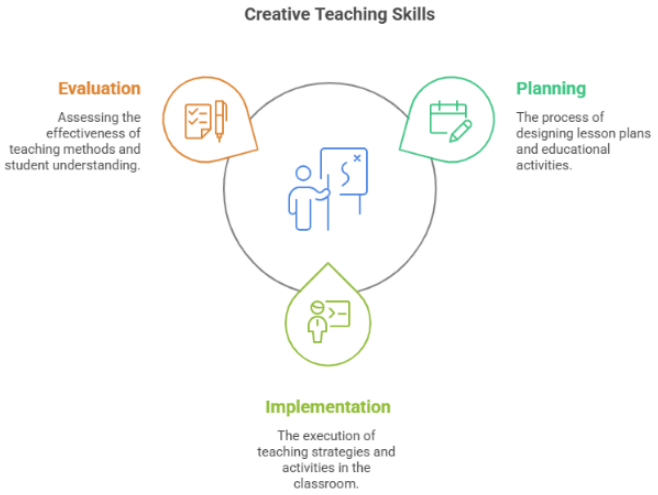

Figure 1. Creative Teaching Skills Categories

Figure 1 illustrates the creative teaching skills that Maths teachers should possess. The list of statements was developed and validated by experts specializing in curriculum, teaching methods, and technology areas. The creative teaching skills category related to planning consists of 15 items, the creative teaching skills category related to implementation consists of 14 items and the creative teaching skills category related to evaluation consists of 12 items. The I-CVIs of all the items in the interview card ranged from 0.80 to 1.00, with only two items having an I-CVI of 0.8, indicating high content validity. In terms of the overall relevance of the questionnaire, represented by the S-CVI values, the results also exceeded the cut-off point of 0.8, with the S-CVI (overall) being 0.95. Suggests that the items developed were important and relevant for measuring creative teaching skills categories.

Creative planning is a crucial first step in the teaching process. Prospective teachers who master this skill can design lesson plans that fulfill curriculum standards and encourage active student engagement. They can integrate technology, such as AI applications, to support more interactive and adaptive learning.[36] A study by showed that teachers who design learning with innovative approaches are more successful in increasing students' learning motivation.

[36] Kaufman and Beghetto, "Beyond Big and Little: The Four C Model of Creativity".

At the implementation stage, flexibility and adaptation skills are indispensable. This research found that prospective teachers who can adapt their teaching methods according to student responses can improve learning effectiveness. They use diverse learning strategies and technology to provide rich and varied learning experiences. Research by[37] also supports these findings, stating that flexible teaching approaches can create a more inclusive and supportive learning environment.

Creative learning evaluation is another important aspect identified in this study. Prospective teachers who use innovative evaluation methods can assess students' understanding more comprehensively, not only from the cognitive aspect but also from their creativity and engagement in the learning process. Previous research by showed that evaluations that cover different aspects of students' skills can provide a more holistic picture of their development. Creative thinking skills are important in identifying prospective mathematics teachers' creative behavior to foster creativity in teaching mathematics. By mastering these skills, prospective teachers can design, implement, and evaluate more effective learning, improving student learning outcomes. This finding is in line with various studies that highlight the important role of creativity in education.[38]

Prospective Maths Teachers with Creative Teaching Skills.

The preparation of interview cards has been adjusted to the categories of creative teaching skills discussed earlier. The statement items were used to see the extent to which the prospective Maths teachers have the ability of creative teaching skills. The mean scores and standard deviations are shown in table 1.

Table 1.

Category	Sub-Category	Average	Standard Deviation	Mastery Level	Interpretation
Planning	Fluency	2.820	0.216	Average mastery	Teacher candidates are quite good at generating many ideas for lesson planning
	Flexibility	2.440	0.199	Average mastery	The adaptability of planning methods is still average
	Authenticity	2.319	0.244	Average mastery	Unique creativity in lesson planning is at an average level
Implementation	Fluency	2.473	0.166	Average mastery	The ability to generate ideas during the implementation of learning is quite good

[37] Kaufman and Beghetto, "Beyond Big and Little: The Four C Model of Creativity."

[38] Vera Septi Andrini, "The Effectiveness of Inquiry Learning Method to Enhance Students' Learning Outcome: A Theoritical and Empirical Review", *Journal of Education and Practice* 7, no. 3 (2016): 38–42, www.iiste.org; Julia Bluestone et al., "Effective In-Service Training Design and Delivery: Evidence from an Integrative Literature Review", *Human Resources for Health* 11, no. 1 (October 1, 2013): 1–26, https://doi.org/10.1186/1478-4491-11-51/TABLES/7.

	Flexibility	1.644	0.315	Not capable	Difficulty in adapting to different situations during implementation
	Authenticity	1.615	0.351	Not capable	Challenges in demonstrating unique creativity during teaching implementation
Assessment	Fluency	1.601	0.361	Not capable	Difficulty in generating many ideas during the assessment process
	Flexibility	1.773	0.367	Not capable	Adaptability in the assessment process is still weak
	Authenticity	1.473	0.469	Not capable	Creativity in assessment methods needs to be improved
Overall	Ability Level	1.955	0.183	Not capable	Prospective teachers must improve their creative teaching skills, especially flexibility and originality

The results showed that prospective Mathematics teachers had variations in their mastery of creative teaching skills based on three main categories: planning, implementation, and assessment. In the planning category, prospective teachers showed a relatively high level of fluency with an average of 2.820, demonstrating their ability to generate diverse ideas in lesson planning. Flexibility in planning was also quite good, with an average of 2.440, although there is still room for improvement. Originality in planning recorded an average of 2.319, indicating challenges in creating original and innovative lesson plans can be attributed to various factors, e.g., lack of adequate knowledge of the steps in planning creative teaching and lack of training in creative teaching skills. This finding aligns with research by[39] who emphasized the importance of creative planning skills to improve teaching effectiveness.

In the implementation category, the results show that fluency in implementing teaching strategies is quite good, with an average of 2.473. However, flexibility in implementation recorded an average of 1.615, indicating that prospective teachers still face challenges in adapting teaching strategies to different conditions. Originality in implementation also showed a low average of 1.601, signaling the need for improvement in adopting unique teaching approaches. This study by highlights that flexibility and originality in implementation are key to dealing with diverse student needs.

[39] Esquivel, "Teacher Behaviors That Foster Creativity".

The assessment categories show that fluency in developing and adjusting assessment tools still requires improvement, with an average of 1.643. Flexibility in assessment has an average of 1.773, indicating that prospective teachers can adapt assessment methods to some conditions but not consistently. Originality in assessment with an average of 1.969 indicates that prospective teachers are starting to develop innovative assessment methods but still need further support. These data suggest that prospective teachers excel more in planning skills than implementation and assessment, confirms the importance of additional training to increase flexibility and originality, particularly in implementation and assessment, as supported by recent literature in creative and innovative education.

Use of AI ChatGPT Model in Developing Maths Teacher Skills

ChatGPT, a language-based AI model, has significant potential to support learning. It enables teachers to provide personalized learning materials, answer students' questions quickly, and support teachers' reflections on their teaching. For prospective mathematics teachers, ChatGPT can be a tool that assists them in developing fluency and flexibility in structuring and delivering teaching materials, which are two key characteristics of creative teaching. AI technology in teaching and learning is also recognized to increase teachers' sensitivity to the problems students face in understanding complex mathematical concepts.[40]

A panel of five experts specializing in curriculum design and teaching methodologies evaluated the proposed AI ChatGPT framework's feasibility, relevance, and applicability. The results, as presented in Table 2, show unanimous approval of the proposed framework, with all experts agreeing that the framework is important, relevant, and applicable to enhance creative teaching skills among female secondary school mathematics teachers.

Table 2: Experts' Views on the Proposed ChatGPT Framework

Standard	Applicability of the Proposed Framework	Relevance of the Proposed Framework	Applicability and Feasibility
Appropriate	9	9	9
Not Suitable	0	0	0
Important	9	9	9
Does Not Matter	0	0	0
Possible	9	9	9
Not Possible	0	0	0
Number of Expert Responses [44]	100%	100%	100%

[40] Lameras and Arnab, "Power to the Teachers: An Exploratory Review on Artificial Intelligence in Education".

These results confirm the strong endorsement of the framework's practicality, indicating that it can be effectively implemented to enhance teachers' creative teaching abilities. The unanimous agreement among experts highlights the perceived necessity of improving teaching skills through AI integration. Furthermore, activating AI in teacher education aligns with broader national and global initiatives to integrate artificial intelligence across various sectors, including education. The recommended action plan for implementing this framework involves organizing seminars and workshops on AI adoption, covering essential prerequisites, benefits, and challenges associated with the technology. Specially designed training programs should also be introduced for female instructors who aspire to use ChatGPT AI in their classrooms, ensuring gender-inclusive access to AI-enhanced teaching methodologies.

A framework for integrating ChatGPT in the skills development of prospective mathematics teachers must begin with a clear mechanism for activating and utilizing the model. Activation involves two main components: training prospective teachers to understand how the ChatGPT model works and developing standard operating procedures for its use. The training process involves simulating teaching using ChatGPT, designed to help prospective teachers explore the role of AI in designing, implementing, and evaluating teaching.[41] In addition, the operational procedures include guidance on integrating ChatGPT into lesson planning, including creating adaptive learning scenarios, crafting clear instructions, and providing data-based feedback to students. Thus, these mechanisms ensure that the use of ChatGPT is not only limited to providing information but also contributes to the creation of an innovative learning environment.

The ChatGPT AI implementation plan involves two main stages: implementing, assessing, and designing the pedagogical teaching framework. In the first stage, prospective teachers utilize ChatGPT to design innovative lessons, facilitate collaborative learning, and reflect on the model's effectiveness in improving student understanding. The study,[42] showed that AI technology can improve teaching quality through in-depth analysis of communication patterns and pedagogical strategies. The second phase focuses on developing a pedagogical framework integrating AI technology for designing, implementing, and evaluating creative learning.

The findings of this study reinforce the idea that ChatGPT AI has the potential to transform mathematics teacher education by providing structured, adaptive, and interactive pedagogical

[41] Dongbo Zhou, Sannvya Liu, and Simone Grassini, "Shaping the Future of Education: Exploring the Potential and Consequences of AI and ChatGPT in Educational Settings," *Education Sciences 2023, Vol. 13, Page 692* 13, no. 7 (July 7, 2023): 692, https://doi.org/10.3390/EDUCSCI13070692.

[42] Marta Montenegro-Rueda et al., "Impact of the Implementation of ChatGPT in Education: A Systematic Review," *Computers 2023, Vol. 12, Page 153* 12, no. 8 (July 29, 2023): 153, https://doi.org/10.3390/COMPUTERS12080153.

support. As AI technology continues to evolve, it is imperative to systematically integrate it into teacher training programs, ensuring that future educators possess the skills necessary to foster innovative and dynamic learning environments. Through continued research and development, AI-driven pedagogy can play a pivotal role in shaping the future of education, making it more inclusive, engaging, and effective.

CONCLUSION

This study reveals that integrating the ChatGPT artificial intelligence model in training prospective mathematics teachers improves creative teaching skills, especially in lesson planning. This study's findings indicate that ChatGPT helps prospective teachers generate innovative ideas and design more adaptive learning. However, implementation and evaluation skills still need to be strengthened, especially regarding flexibility and authenticity in teaching. The main lesson learned from this study is that AI technology can be an effective pedagogical tool if systematically integrated into teacher education programs so that prospective teachers understand the concept of creative teaching and apply it in authentic learning situations.

In terms of academic contribution, this study enriches the perspective on using AI in education, especially in teacher training. This study offers a new approach to technology-based learning and presents a model for developing teaching skills based on artificial intelligence. By adopting a descriptive-analytical methodology and using a structured interview instrument, this study provides deeper insights into how ChatGPT can be effectively utilized in teacher education. The results of this study also form the basis for developing more innovative training strategies which combine AI technology with modern pedagogical principles.

However, this study has several limitations. First, this study only involved 47 prospective mathematics teachers from one educational institution, so the generalization of the results is still limited. Second, this study has not considered differences based on gender, age, or teaching experience, which can affect the acceptance and effectiveness of using ChatGPT in learning. Third, the method used is still based on interviews and descriptive analysis, so it has not fully explored the long-term impact of AI in teacher education. Therefore, further research with a broader scope, involving more diverse samples, and using more varied methods such as longitudinal surveys or experiments is needed. With a more comprehensive approach, the study's results can provide a more complete picture to support more appropriate policies in developing AI-based teacher education.

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