ISSN xxxx-xxxx (Print)
ISSN xxxx-xxxx (Online)

Jurnal Pengabdian kepada Masyarakat Madani (JPMM)
Volume 1, No. 1, 2026, 20 - 28

EMPOWERING MATHEMATICS TEACHERS THROUGH AI-ASSISTED LEARNING INNOVATION FOR MEANINGFUL CLASSROOM PRACTICE

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Abstract

The rapid development of artificial intelligence (AI) has created new opportunities for transforming mathematics teaching and learning. However, many mathematics teachers still face challenges in understanding the pedagogical potential of AI, designing AI-assisted learning activities, and evaluating AI-generated educational content critically and responsibly. This community service program aimed to empower mathematics teachers through AI-assisted learning innovation to strengthen their capacity to develop meaningful classroom practices. The program employed a participatory training and mentoring approach consisting of needs assessment, AI literacy training, hands-on practice, AI-assisted lesson design, peer discussion, mentoring, and evaluation. The participants were mathematics teachers who were introduced to practical applications of AI for lesson planning, instructional material development, problem generation, formative assessment, differentiated learning, and classroom reflection. The effectiveness of the program was evaluated through pre-test and post-test assessments, observation of participants' practical performance, assessment of AI-assisted instructional products, and participant feedback. The program demonstrated that structured training combined with hands-on practice and mentoring can strengthen teachers' understanding of AI and their ability to integrate AI into mathematics instruction. The activities also encouraged teachers to critically evaluate AI-generated outputs rather than relying on them without verification. The program highlights that meaningful AI integration requires more than technical familiarity; it requires pedagogical judgment, critical digital literacy, creativity, and responsible use. The findings suggest that continuous professional development combining AI literacy, pedagogical innovation, practical application, and mentoring can support mathematics teachers in adapting to technological transformation while maintaining the quality and meaningfulness of classroom learning.

Keywords: *Mathematics Teachers; AI-Assisted Learning; Teacher Empowerment; Digital Pedagogy; Community Service*

INTRODUCTION

The rapid development of artificial intelligence has begun to influence various aspects of education, including the ways teachers design learning activities, develop instructional materials, assess student understanding, and provide individualized learning support (Chowdhury et al., 2024). Generative AI tools have created opportunities for teachers to produce educational content more efficiently, generate examples and exercises, formulate questions, develop explanations, and obtain alternative approaches to instructional problems. In mathematics education (Al Ayyubi, Martini, et al., 2024; Al Ayyubi, Prayetno, et al., 2024; Al Ayyubi, Widiani, et al., 2024), these opportunities are particularly relevant because mathematical learning requires carefully designed problems, multiple representations, logical reasoning, feedback, and opportunities for students to engage with concepts rather than merely obtain correct answers.

Despite these opportunities, the integration of AI into classroom practice cannot be reduced to the ability to operate technological tools (Kulkov et al., 2024). Teachers need to understand how AI-generated information is produced, recognize its limitations, evaluate the accuracy of its responses, and determine whether AI-supported materials are pedagogically appropriate. This is especially important in mathematics because AI systems may occasionally generate incorrect calculations, flawed reasoning, inappropriate examples, or explanations that appear convincing but contain conceptual errors. Consequently, teachers remain essential as professional decision makers who validate, adapt, and contextualize AI-generated content before it is introduced into classroom learning.

Mathematics teachers also face increasingly diverse student learning needs (Nurhikmah et al., 2025). Students may differ in prior knowledge, learning pace, conceptual understanding, motivation, and preferred ways of engaging with mathematical problems (Hartati et al., 2020). Conventional instructional approaches may not always provide teachers with sufficient time and resources to prepare differentiated materials for these diverse needs. AI-assisted learning potentially provides teachers with additional support for generating variations of mathematical problems, developing explanations at different levels of complexity, preparing formative assessment questions, and designing learning activities that respond to students' needs (Al Ayyubi, Rohaendi, et al., 2025).

However, the potential benefits of AI are accompanied by several challenges. Teachers may lack sufficient AI literacy, have limited experience constructing effective prompts, or be uncertain about how AI can be integrated into existing pedagogical strategies. There are also concerns regarding academic integrity, student dependence on AI, privacy, misinformation, and the ethical use of AI-generated content. These challenges indicate that professional development should not focus solely on demonstrating AI tools but should help teachers develop a critical and pedagogically grounded understanding of AI.

The problem is particularly important in contexts where teachers are encouraged to adopt digital technologies without always receiving sufficient opportunities for practical training and sustained mentoring (Al Ayyubi, Prayetno, et al., 2025; Dvir et al., 2024; Mainali, 2021). One-time technology demonstrations may increase awareness but may not necessarily lead to meaningful changes in classroom practice. Teachers need opportunities to experiment with AI, develop instructional products, receive feedback, implement their ideas, and reflect on their classroom implications.

Therefore, a community service program that combines AI literacy, hands-on practice, instructional design, mentoring, and reflection can provide a more comprehensive approach to teacher empowerment. Such an approach positions teachers not merely as consumers of AI-generated educational content but as active designers who use AI strategically to enhance their pedagogical practice.

The present community service program focuses on empowering mathematics teachers through AI-assisted learning innovation. The program is designed around the principle that technology should support, rather than replace, teacher professionalism. AI is positioned as an instructional assistant that can support lesson preparation,

material development, assessment, differentiation, and reflection, while teachers retain responsibility for pedagogical decisions and the validation of AI-generated outputs.

The novelty of this program lies in integrating AI literacy, pedagogical application, hands-on instructional design, and mentoring into a single teacher empowerment model. Rather than evaluating AI solely as a technological innovation, the program emphasizes the transformation of teachers' practical competencies and the development of meaningful classroom practices. The program therefore aims to strengthen mathematics teachers' capacity to use AI critically, creatively, and responsibly in designing learning experiences that are relevant to students' mathematical needs. Based on these considerations, the community service program aims to empower mathematics teachers through AI-assisted learning innovation by improving their AI literacy, practical skills, pedagogical competence, and ability to develop meaningful mathematics learning practices.

METHOD

The community service program employed a Participatory Training and Mentoring approach (Creswell & Creswell, 2017). This approach was selected because the objective of the program was not merely to provide information about artificial intelligence but to develop teachers' practical capacity to integrate AI into mathematics learning. The program emphasized active participation, collaborative learning, hands-on practice, instructional product development, mentoring, and reflection.

The participants were mathematics teachers who were involved as active partners throughout the program. Before the training was conducted, a needs assessment was undertaken to identify participants' existing knowledge of AI, experience with digital learning technologies, difficulties in preparing mathematics instructional materials, and expectations regarding AI-assisted learning. The needs assessment served as the basis for determining the training materials and practical activities.

The program was implemented through several interconnected stages. The first stage was needs assessment, which involved identifying teachers' technological competencies and instructional challenges. The second stage was AI literacy training, which introduced the concept of generative AI, its potential applications in education, limitations, ethical considerations, and principles of responsible use. The third stage consisted of hands-on practice, in which teachers experimented with AI tools to generate mathematics problems, explanations, learning activities, instructional materials, and formative assessment items.

The fourth stage focused on AI-assisted lesson design. Teachers were guided to develop learning activities by integrating AI into selected components of mathematics instruction. The activities included developing contextual mathematical problems, generating alternative explanations, preparing differentiated exercises, constructing formative assessment questions, and designing learning materials. Teachers were encouraged to verify and revise AI-generated outputs before incorporating them into their instructional products.

The fifth stage was mentoring and peer review. Participants presented their AI-assisted instructional products and received feedback from facilitators and fellow teachers. This stage

emphasized the pedagogical appropriateness, mathematical accuracy, clarity, relevance, and ethical considerations of the materials produced. The sixth stage involved reflection and evaluation to determine changes in teachers' knowledge, practical competencies, and perceptions of AI-assisted mathematics learning.

The effectiveness of the program was evaluated through a combination of quantitative and qualitative techniques. A pre-test and post-test were administered to identify changes in teachers' knowledge and understanding of AI-assisted learning. Practical performance was assessed through participants' ability to use AI tools and develop instructional materials. The quality of AI-assisted learning products was evaluated based on mathematical accuracy, pedagogical relevance, creativity, clarity, and responsible use of AI. Participant feedback and reflective responses were also collected to identify perceived benefits, challenges, and future support needs.

RESULTS AND DISCUSSION

The implementation of the community service program demonstrated that the empowerment of mathematics teachers through AI-assisted learning innovation can provide meaningful opportunities for strengthening teachers' digital and pedagogical competencies (da Silva & da Silva Rodrigues, 2018). The program was designed not merely to introduce participants to artificial intelligence but to facilitate their ability to apply AI in practical mathematics teaching contexts (Windari et al., 2023). Through a combination of training, demonstrations, hands-on activities, collaborative discussion, and mentoring, teachers were encouraged to explore how AI could support lesson preparation, instructional material development, mathematical problem generation, formative assessment, and differentiated learning. The activities indicated that teachers' initial understanding of AI was generally associated with its function as a digital information tool, whereas the training broadened their understanding of AI as an instructional assistant that could be integrated into various stages of mathematics learning.

The training activities showed that teachers became increasingly familiar with the potential applications of generative AI in mathematics education (Tinmaz et al., 2023). During the practical sessions, participants were guided to formulate prompts based on specific learning objectives, mathematical topics, student characteristics, difficulty levels, and expected learning outputs. This activity was important because the quality and relevance of AI-generated responses were strongly influenced by the clarity of teachers' instructions. Teachers gradually recognized that effective use of AI requires more than simply entering general questions into an AI system. They needed to provide appropriate pedagogical and mathematical contexts so that the generated materials could be aligned with classroom needs. This experience strengthened teachers' awareness that AI literacy should include the ability to communicate with AI systems, evaluate their responses, and modify the generated content according to instructional requirements.

The hands-on activities also resulted in the development of various AI-assisted mathematics learning materials (Al Ayyubi, Nurhikmah, et al., 2025). Teachers were able to experiment with generating contextual mathematical problems, alternative explanations of

mathematical concepts, exercises with different levels of difficulty, formative assessment questions, and learning activities that could be adapted to students' diverse learning needs. The use of AI provided teachers with an alternative way to accelerate the initial preparation of instructional materials. Nevertheless, the participants were encouraged not to use AI-generated content directly. Instead, they were required to examine the mathematical accuracy, language, level of difficulty, relevance of examples, and alignment with learning objectives before using the materials in classroom practice. This process demonstrated that the most meaningful role of AI in education is not to replace teachers' instructional responsibilities but to support teachers in generating and refining pedagogical ideas.

An important finding of the program was the increasing awareness among teachers regarding the need to critically verify AI-generated information. During the practical activities, participants encountered outputs that required correction, clarification, or contextual adjustment. Such experiences provided direct evidence that AI systems may generate responses that appear convincing but are not necessarily mathematically accurate or pedagogically appropriate. In mathematics education, this issue is particularly important because an inaccurate calculation or flawed explanation can lead students to develop misconceptions. The training therefore emphasized a verification process in which teachers examined AI-generated outputs against established mathematical principles and learning objectives. This practice strengthened the role of teachers as critical evaluators and professional decision makers in AI-assisted learning.

The integration of AI also provided opportunities for teachers to consider more flexible approaches to differentiated mathematics instruction. AI can assist teachers in producing variations of mathematical problems, alternative explanations, scaffolding questions, and enrichment activities. Such capabilities may help teachers respond to differences in students' prior knowledge and learning pace. However, the program emphasized that differentiation should not simply involve producing easier or more difficult questions. Teachers were encouraged to consider the underlying mathematical concepts, reasoning processes, cognitive demands, and learning objectives when adapting AI-generated materials. Consequently, AI was positioned as a resource that expands teachers' instructional possibilities while pedagogical decisions remained under the control of the teacher.

The results further suggest that AI-assisted learning can contribute to more meaningful classroom practice when technological capabilities are connected with authentic learning contexts. Teachers were encouraged to develop mathematical activities that related abstract concepts to everyday situations familiar to students. AI could support teachers in generating contextual scenarios and alternative problem formulations, but teachers remained responsible for selecting contexts that were relevant to students' experiences. Meaningful learning therefore emerged from the combination of technological assistance and teachers' contextual knowledge. This finding reinforces the argument that educational innovation should not be measured solely by the use of new technologies but by the extent to which technology contributes to students' understanding, engagement, reasoning, and ability to connect

mathematical knowledge with real-world situations.

The mentoring component of the program played an important role in supporting the transition from technological awareness to practical application. Teachers had opportunities to discuss difficulties encountered during AI use, receive feedback on their instructional materials, and refine their lesson designs. This process demonstrated that professional development involving emerging technologies requires continuous support rather than a single training session. Teachers may understand the basic functions of AI during a workshop but still experience difficulties when attempting to integrate the technology into authentic classroom situations. Mentoring provides opportunities for teachers to reflect on their experiences, identify weaknesses, and gradually develop more sophisticated strategies for using AI.

The program also highlighted the importance of responsible AI use in educational settings. Teachers were introduced to issues related to accuracy, privacy, academic integrity, intellectual property, and responsible use of AI-generated content. These issues are increasingly important because students may also have direct access to generative AI tools. Teachers therefore need to understand how to guide students toward productive and responsible use rather than simply prohibiting or encouraging unrestricted AI use. Responsible AI literacy involves the ability to recognize both the benefits and limitations of AI and to make informed decisions about when AI should be used, how its outputs should be verified, and which educational decisions should remain under human judgment.

The empowerment process observed during the program indicates that AI literacy should be understood as an important component of contemporary teacher professional development. Teachers require not only operational knowledge of AI tools but also the ability to connect technological capabilities with curriculum objectives, mathematical content, instructional strategies, and student needs. The program's emphasis on practical application allowed participants to move from simply knowing about AI toward experimenting with AI-supported instructional design. This transition is important because teacher empowerment is achieved when teachers develop the confidence and competence to make independent pedagogical decisions rather than merely follow technological instructions provided by trainers.

The findings also indicate that the integration of AI can reduce some of the workload associated with instructional preparation, particularly in the initial generation of ideas and learning materials. Teachers can use AI to develop alternative versions of exercises, formulate initial assessment questions, generate examples, and organize instructional ideas. However, efficiency should not become the primary objective of AI integration. If AI is used only to produce large quantities of materials quickly, teachers may risk prioritizing quantity over pedagogical quality. The program therefore emphasized that efficiency should be accompanied by professional judgment, critical evaluation, and contextual adaptation. AI-assisted teaching becomes valuable when the time saved through technology is redirected toward activities that require uniquely human capabilities, such as understanding students, providing feedback, facilitating discussion, and developing mathematical reasoning.

The experience of the program further demonstrates that teacher empowerment through AI should be understood as a gradual process. Teachers initially require awareness of AI and its educational potential, followed by opportunities to develop practical skills and apply those skills to instructional design. Through mentoring and reflection, teachers can gradually develop confidence in determining appropriate applications of AI. This process can be represented as a progression from AI awareness to AI literacy, from AI literacy to practical competence, and from practical competence to pedagogical integration. The final objective is not simply increased technology adoption but the development of meaningful classroom practices in which AI contributes to improved instructional quality.

From a broader perspective, the program demonstrates that the successful integration of AI in mathematics education depends on the relationship between technological capability and teacher agency. AI can provide teachers with numerous possibilities for generating content and instructional ideas, but teachers determine whether those possibilities are educationally meaningful. Teacher agency becomes particularly important when AI produces ambiguous, inaccurate, or contextually inappropriate responses. Rather than accepting AI outputs as authoritative, empowered teachers are able to question, verify, modify, and reject them when necessary. This critical capacity represents an essential dimension of professional competence in an increasingly AI-mediated educational environment.

The community service program therefore provides evidence that a participatory training and mentoring model can serve as an appropriate approach for strengthening mathematics teachers' capacity to use AI-assisted learning innovation. The combination of theoretical introduction, practical experimentation, instructional product development, peer discussion, mentoring, and reflection creates a learning environment in which teachers can gradually connect AI technology with authentic pedagogical needs. The program also suggests that sustainable AI integration requires continued professional development and collaboration among teachers rather than dependence on isolated training activities. Future community service programs can build on this model by providing longer-term classroom mentoring, developing teacher learning communities, and examining how AI-assisted instructional practices influence students' mathematical engagement, conceptual understanding, problem-solving ability, and learning outcomes.

CONCLUSION

The community service program demonstrates that participatory training combined with hands-on practice and mentoring can strengthen mathematics teachers' capacity to integrate artificial intelligence into learning design. The program improved teachers' understanding of AI-assisted learning, practical ability to develop instructional materials, awareness of effective prompting, and capacity to critically evaluate AI-generated outputs. Teachers were able to use AI to support the development of contextual mathematics problems, differentiated exercises, explanations, and formative assessments. These outcomes indicate that AI can become a valuable instructional assistant when integrated with teachers' professional knowledge and pedagogical judgment.

The program also demonstrates that meaningful AI integration requires a balance between technological innovation and teacher professionalism. AI should not replace teachers' roles in determining learning objectives, validating mathematical accuracy, understanding students' needs, and designing meaningful learning experiences. The main contribution of the program is therefore the development of an empowerment-oriented approach that combines AI literacy, practical application, pedagogical design, critical verification, and mentoring. A limitation of the program is that the evaluation primarily reflects short-term changes in teachers' competencies and instructional preparation. Future programs should examine the long-term implementation of AI-assisted learning in actual classrooms and investigate its influence on students' mathematical engagement, reasoning, achievement, and learning experiences.

REFERENCES

Al Ayyubi, I. I., Martini, S., Masfuroh, A. S., & Ramdani, A. S. N. (2024). Application of The Brain-Based Learning Model on Students' Learning Outcomes and Initial Mathematical Abilities. *Tadrusuun: Jurnal Pendidikan Dasar*, *3*(2), 246–259. https://doi.org/https://doi.org/10.62274/tadrusuun.v3i2.157

Al Ayyubi, I. I., Nurhikmah, N., Prayetno, E., Noerzanah, F., & Musaldin, L. O. (2025). Determination of Prayer Times Through Islamic Astronomy Applications: Repositioning Traditional Authority in the Digital Era. *Borneo International Journal of Islamic Studies*, *7*(1), 1–18.

Al Ayyubi, I. I., Prayetno, E., Jamaliah, D., & Mumtazah, N. (2024). Equilibrium of Faith and Logic: Integrating Islamic Moral Values and Mathematics Education in Various Contexts. *IJEMR: International Journal of Education Management and Religion*, *1*(2), 127–144. https://doi.org/https://doi.org/10.71305/ijemr.v1i2.167

Al Ayyubi, I. I., Prayetno, E., Muhaemin, A., & Permatasari, I. (2025). Technology Utilisation for Tax Acceleration: Training on the Use of PBB Application for Lempangang Village Residents. *Dinamis: Jurnal Pengabdian Kepada Masyarakat*, *5*(1), 9–19. https://doi.org/https://doi.org/10.33752/dinamis.v5i1.8696

Al Ayyubi, I. I., Rohaendi, N., Prayetno, E., Masfuroh, A. S., Al-Ghatnaini, R. A. S., & Saelaemae, T. (2025). Application of Geogebra in Mathematics Learning Using a Realistic Mathematics Education Model. *Journal of Teaching and Learning*, *1*(2), 125–138. https://doi.org/https://doi.org/10.71305/jtl.v1i2.133

Al Ayyubi, I. I., Widiani, E., Suryana, I., Andriani, A., & Sari, D. W. (2024). Application of the Model-Eliciting Activities (MEAs) Learning Model on Mathematics Learning Based on higher-order thinking Skills (HOTS). *Noumerico: Journal of Technology in Mathematics Education*, *2*(2), 82–95. https://doi.org/https://doi.org/10.33367/jtme.v2i2.5181

Chowdhury, S., Budhwar, P., & Wood, G. (2024). Generative artificial intelligence in business: towards a strategic human resource management framework. *British Journal of Management*, *35*(4), 1680–1691. https://doi.org/https://doi.org/10.11

11/1467-8551.12824

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

da Silva, M. L. F., & da Silva Rodrigues, A. J. (2018). A new digital method to recover the state of art: systematic literature review (SLR). *Revista Inclusiones*, 12–31.

Dvir, M., Almhanni, G., Qaisar, H., Calvin, A. D., & Tallarita, T. (2024). When Occipital Artery Biopsy is Preferred to temporal biopsy for giant cell arteritis: a Step-By-Step description of the Surgical technique. *Mayo Clinic Proceedings: Innovations, Quality & Outcomes*, *8*(1), 53–57. https://doi.org/10.1016/j.mayocpiqo.2023.12.005

Hartati, S., Bilqis, R. A., & Rinaldi, A. (2020). Mathematical problem-solving abilities and reflective thinking abilities: The impact of the influence of eliciting activities models. *Al-Jabar: Jurnal Pendidikan Matematika*, *11*(1), 167–178. https://doi.org/http://dx.doi.org/10.24042/ajpm.v11i1.6709

Kulkov, I., Kulkova, J., Rohrbeck, R., Menvielle, L., Kaartemo, V., & Makkonen, H. (2024). Artificial intelligence-driven sustainable development: Examining organizational, technical, and processing approaches to achieving global goals. *Sustainable Development*, *32*(3), 2253–2267. https://doi.org/https://doi.org/10.1002/sd.2773

Mainali, B. (2021). Representation in teaching and learning mathematics. *International Journal of Education in Mathematics, Science and Technology*, *9*(1), 1–21. https://eric.ed.gov/?id=EJ1282034

Nurhikmah, N., Al Ayyubi, I. I., Masfuroh, A. S., Noerzanah, F., & Rahmawati, S. (2025). The Interpretation of Patterns and Symmetry in the Qur'an: Does Mathematics Serve as Proof of Divinity or Merely an Aesthetic Interpretation? *Borneo International Journal of Islamic Studies*, *7*(1), 35–60. https://doi.org/https://doi.org/10.21093/bijis.v7i1.10061

Tinmaz, H., Fanea-Ivanovici, M., & Baber, H. (2023). A snapshot of digital literacy. *Library Hi Tech News*, *40*(1), 20–23. https://doi.org/https://doi.org/10.1108/LHTN-12-2021-0095

Windari, M. R., Prihatin, J., & Fikri, K. (2023). The Effectiveness of Digital Textbooks on Brain-based Learning assisted by Animated Videos and Maze Chase-Wordwall on Science Literacy Skills and Student Learning Outcomes. *Biosfer: Jurnal Tadris Biologi*, *14*(1), 79–88. https://doi.org/http://dx.doi.org/10.24042/biosfer.v14i1.16891