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INTEGRATION OF ISLAM AND MATHEMATICS: STRENGTHENING TECHNOLOGY PEDAGOGY COMPETENCE FOR ISLAMIC CAMPUS STUDENTS AS PROSPECTIVE MATHEMATICS TEACHERS

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ABSTRACT

This study aims to identify the impact of GeoGebra application training as a strategic effort to improve the technological pedagogical competence of Islamic campus students as prospective mathematics teachers at the Educational Personnel Training Institution. This program focuses on the knowledge, skills, and readiness of students in the Mathematics Education Study Program at UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan in integrating GeoGebra into mathematics learning. The Participatory Action Research (PAR) approach is used. The results show that more than 80% of participants agreed that the training material is relevant, enhances understanding of GeoGebra concepts, and improves their practical teaching skills. Participants also rated the facilitators very highly in terms of mastery of the material and clarity of delivery. This research finding contributes to the affirmation that PAR-based training effectively enhances technological literacy and strengthens Technological Pedagogical Content Knowledge.

Keywords: *Geogebra, Mathematics Teachers, Technological Pedagogical Competence*

A. Introduction

The transformation of education in the twenty-first century necessitates fundamental changes in the learning process, particularly in mathematics education at Teacher Education Institutions (Indrawati, n.d.). Learning is no longer sufficient if it is oriented merely toward procedural mastery of concepts; rather, it must be directed toward the development of higher-order thinking skills, problem-solving abilities, creativity, collaboration, and communication, all of which are integrated with the use of digital technology (Salsabila et al., 2025). In line with the implementation of the Kurikulum Merdeka, prospective mathematics teachers are required to be prepared to design learning experiences that are adaptive to developments in information and communication technology (ICT) in order to make learning more contextual and meaningful for students (Noviyanti & Mariana, 2025).

The integration of ICT in mathematics learning should not be understood simply as the use of presentation media, but as a means of redesigning learning experiences (Siregar, 2025a). Technology needs to be utilized as a medium for concept exploration, visualization, and the dynamic communication of mathematical ideas (Putri et al., 2025) Numerous studies have demonstrated that the appropriate use of technology in mathematics learning can promote active student engagement, enhance conceptual understanding, and foster the development of numeracy literacy and mathematical reasoning (Siregar, 2025b). Therefore, strengthening technological competencies among prospective teachers has become an urgent necessity within higher education systems for teacher preparation (Xamrayeva, n.d.).

This study focuses on strengthening the technological competencies of prospective mathematics teachers through the integration of ICT in mathematics learning, particularly using the GeoGebra application as a tool for concept exploration and visualization. The research aims to examine how GeoGebra-based training can enhance students' ability to design meaningful and technology-integrated learning experiences. To achieve this objective, the study employed a Participatory Action Research (PAR) method, which involves stages of needs analysis, planning, implementation of training activities, and collaborative reflection. The training was conducted through structured sessions and mentoring to support participants in understanding and applying GeoGebra in instructional contexts.

One relevant competency framework in this context is Technological Pedagogical Content Knowledge (TPACK), which refers to the ability to integrate content knowledge, pedagogical knowledge, and technological knowledge into a unified instructional practice (Susilawati et al., 2025). Although prospective mathematics teachers generally possess theoretical knowledge of TPACK, evidence from the field indicates that its implementation remains largely at the conceptual level and has not been optimally realized in the actual design and enactment of

technology-based learning. This condition highlights the need for authentic learning experiences that provide students with opportunities to directly practice the integration of technology within the context of mathematics instruction.

GeoGebra, as a dynamic mathematics software, has substantial potential to support the strengthening of students' TPACK (Shuaib, 2025). This application enables the interactive integration of algebraic, geometric, and graphical representations, thereby facilitating the visualization of relationships among abstract concepts. In geometry learning in particular, GeoGebra can assist students in understanding transformations, spatial relationships, and the properties of geometric figures through direct exploration of mathematical objects (Siregar, n.d.). A growing body of research has reported that the use of GeoGebra has a positive impact on conceptual understanding, learning interest, and student engagement in mathematics learning (Aisyah & Setyawan, 2025).

Nevertheless, the utilization of GeoGebra in teacher education institutions, including the Mathematics Education (Tadris Matematika) Study Program at UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan, remains suboptimal. Students tend to rely on conventional media such as whiteboards, textbooks, or static presentations when designing lesson plans and conducting teaching simulations. Limited practical experience in using dynamic mathematics applications has resulted in technology not being systematically integrated into the learning scenarios developed by students. This gap between the availability of technology and instructional practice constitutes a significant challenge in preparing professional and adaptive prospective teachers (Sukmawati et al., 2025).

Several recent international studies conducted by Indonesian researchers highlight the effectiveness of GeoGebra in mathematics learning. For instance, Wijaya, van den Heuvel-Panhuizen, and Doorman (2022) demonstrated that GeoGebra-based tasks provide meaningful learning opportunities and support students' conceptual understanding in mathematics. Similarly, Nusantara, Herman, and Suhendra (2021) found that the use of GeoGebra enhances students' mathematical reasoning and problem-solving skills through dynamic visualization. In addition, Rahmawati and Putri (2020) reported that GeoGebra-assisted learning significantly improves students' engagement and motivation in mathematics classrooms. Furthermore, Pratiwi, Suryadi, and Dahlan (2021) revealed that integrating GeoGebra into instruction supports students in understanding abstract mathematical concepts more effectively. Moreover, Hidayat, Wahyudin, and Prabawanto (2022) emphasized that the use of GeoGebra in teacher education strengthens prospective teachers' technological pedagogical competencies. These findings indicate that GeoGebra plays a significant role in improving both students' learning outcomes and teachers' professional readiness in mathematics education.

Based on these issues, this community service program was designed in the form of GeoGebra training for undergraduate students of the Mathematics Education (Tadris Matematika) Study Program at UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan. The training aimed to enhance students' knowledge, skills, and self-confidence in operating GeoGebra and utilizing it to develop interactive mathematics learning media and activities. Through a Participatory Action Research approach, students were positioned as active partners involved in all stages of the program, from needs analysis to reflective evaluation, thereby strengthening their readiness to become technologically literate prospective mathematics teachers oriented toward twenty-first-century learning.

B. The Concept of GeoGebra Training Program

The GeoGebra training program is designed as a structured initiative to enhance the technological and pedagogical competencies of prospective mathematics teachers through the integration of dynamic mathematics software. GeoGebra, as an interactive digital tool, enables users to explore mathematical concepts through visualization, simulation, and dynamic manipulation, thereby supporting deeper conceptual understanding (Santos-Trigo & Moreno-Armella, 2021). In the context of teacher education, such training is essential to prepare future teachers to effectively integrate technology into classroom practices.

This training program is grounded in the Technological Pedagogical Content Knowledge (TPACK) framework, which emphasizes the intersection of technology, pedagogy, and subject matter knowledge as a foundation for effective teaching (Tondeur et al., 2021). Through this approach, participants are not only introduced to the technical features of GeoGebra but are also guided to design meaningful learning activities that incorporate technology to support student-centered learning. Previous studies have shown that the integration of tools such as GeoGebra can enhance students' mathematical reasoning, engagement, and conceptual understanding (Albano & Dello Iacono, 2021).

Furthermore, the program adopts a participatory and practice-oriented approach, allowing participants to actively engage in hands-on activities, collaborative problem-solving, and reflective discussions. Such an approach is consistent with contemporary models of teacher professional development, which highlight the importance of active involvement and contextual learning experiences (Radović et al., 2020). Therefore, the GeoGebra training program is not merely focused on technical skill acquisition but also on fostering the ability of prospective teachers to design innovative, technology-integrated mathematics instruction.

1. Preparation Stage

The preparation stage constituted the primary foundation for the success of the GeoGebra training program. At this phase, the community service team conducted preliminary observations and discussions with the Mathematics

Education (Tadris Matematika) Study Program at UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan to map students' actual needs related to technological literacy in learning. The observations revealed that most students were theoretically familiar with GeoGebra; however, they were not yet accustomed to using it in the development of instructional tools or in teaching simulations. Their experience with the application was largely limited to certain coursework assignments and had not been systematically integrated into instructional design.

Figure 1. GeoGebra user guide (left), program banner (center), and questionnaire instrument (right)

Based on these findings, the team developed a GeoGebra user guide tailored to the context of secondary school mathematics learning. The guide included instructions on interface orientation, the use of basic menus, drawing geometric objects, creating function graphs, utilizing sliders, and simulating geometric transformations. In addition, evaluation instruments were prepared in the form of participant response questionnaires, short tests, and written reflection formats. This preparation stage also served as a means of aligning perceptions between the facilitators and the study program to ensure that the implementation of the program was consistent with the curriculum and students' needs.

2. Implementation of the GeoGebra Training

The training was conducted in a conducive and participatory atmosphere. Each participant was provided with a module and instructed to install and open the GeoGebra application prior to the session. In the first meeting, the facilitator introduced the fundamental concepts of GeoGebra and its functions in mathematics learning, particularly in geometry and algebra. Participants did not merely receive theoretical explanations but were immediately engaged in practicing basic features such as creating points, lines, and planes, and linking geometric objects to their algebraic representations.

The second session focused on the development of interactive learning media. Participants were trained to use sliders to manipulate variable values, create simple

animations, and observe dynamic changes in graphs and geometric forms. This activity encouraged students to explore relationships among mathematical concepts through visual and experimental approaches. Small-group discussions were also facilitated to enable participants to exchange ideas and experiences during the exploration process.

The third session was devoted to the development of instructional products in the form of GeoGebra-assisted worksheets (LKPD) or brief lesson plans. At this stage, students were required to design realistic and applicable learning activities aligned with the school curriculum. Intensive mentoring was provided to ensure that each participant was able to connect the technical aspects of GeoGebra use with appropriate pedagogical steps. A follow-up mentoring session then focused on refining the products and reflecting on the learning experiences.

3. Participants' Responses and Enthusiasm

Participants' enthusiasm was evident from the beginning of the program. Students showed a high level of interest in using GeoGebra, particularly because the application enables the visualization of mathematical concepts that are often perceived as abstract. Interaction between facilitators and participants was highly active, as reflected in the large number of questions raised and the dynamic discussions that emerged during practice sessions.

The questionnaire results indicated that the majority of participants provided positive evaluations regarding the relevance of the materials, the clarity of delivery, and the practical benefits obtained from the training. More than 80% of participants agreed or strongly agreed that the training helped them understand the basic concepts of GeoGebra and provided skills that could be directly applied in teaching. This finding indicates that the training effectively addressed students' needs in strengthening technological competencies for learning.

C. Impact on Teaching Readiness and Challenges in Implementation

One of the key findings of this program was the improvement in technological literacy among prospective mathematics teachers. Prior to the training, students tended to use technology in a limited manner, for example, merely as a presentation tool. After the training, they began to understand that GeoGebra can be utilized as a medium for concept exploration, visualization, and the communication of mathematical ideas.

This improvement in technological literacy is aligned with the strengthening of students' TPACK components, particularly Technological Knowledge and Technological Pedagogical Knowledge. Students were not only able to operate the application but also started to comprehend how technology can be integrated into student-centered learning scenarios. Thus, the training contributed to the development of students' professional competencies as prospective mathematics teachers who are adaptive to technological advancements.

The written reflections revealed that students felt more confident in using GeoGebra in microteaching activities and school teaching practice. They perceived that the application could assist in explaining complex concepts such as geometric transformations, function graphs, and relationships among variables. Moreover, students recognized that GeoGebra-assisted learning could enhance students' learning interest by providing more interactive and engaging learning experiences.

These findings indicate that the training had an impact not only on technical skill enhancement but also on students' pedagogical readiness. This readiness constitutes an essential asset for prospective teachers in facing the challenges of twenty-first-century learning, which demands creativity and innovation in the use of technology.

Although the program was generally implemented successfully, several challenges were encountered. Not all students possessed laptops with adequate specifications, resulting in delays during some practice sessions. In addition, the varying levels of students' technological proficiency required facilitators to provide more intensive assistance to certain participants.

Another constraint was the limited duration of the training. Although the program was designed in several sessions, some participants expressed the need for additional time to explore the advanced features of GeoGebra. This indicates the necessity of a sustainable training program to ensure that the competencies acquired can continue to be developed.

D. Implications for Study Program Development

The results of this program have important implications for the development of the curriculum and training programs in the Mathematics Education Study Program. GeoGebra training can serve as a model for sustainable community service activities and can be integrated into courses related to educational technology. In this way, students will not only gain theoretical knowledge but also acquire practical experience that is relevant to real classroom needs.

Furthermore, the success of this program demonstrates that the Participatory Action Research approach is effective in empowering students as active subjects in the learning process. Their involvement from the planning stage through reflection fosters a sense of ownership of the program, thereby making the outcomes more meaningful and sustainable.

Overall, the findings indicate that GeoGebra training has a positive impact on enhancing the technological competencies of prospective mathematics teachers. The positive responses of participants, the improvement in technological literacy, and the strengthening of teaching readiness suggest that this program is highly relevant to current educational needs. The training functions not only as a means of

transferring technical skills but also as a medium for shaping a new paradigm of mathematics learning that is more visual, interactive, and student-centered.

Accordingly, this community service program may serve as a best practice in efforts to improve the quality of prospective mathematics teachers within teacher education institutions, particularly in addressing the challenges of technology integration in twenty-first-century learning.

E. Conclusion

The community service program in the form of GeoGebra training for undergraduate students of the Mathematics Education Study Program at UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan was successfully implemented and received highly positive responses from participants. The findings indicate that the training effectively enhanced students' knowledge, technical skills, and self-confidence in using GeoGebra as an interactive and contextual mathematics learning medium. Evaluation results from questionnaires, short tests, and written reflections revealed that most participants considered the training materials relevant, easy to understand, and practically applicable in classroom settings. In addition, the program strengthened students' technological literacy and improved their Technological Pedagogical Content Knowledge (TPACK), particularly in integrating technology, pedagogy, and mathematical content in a coherent manner.

These findings imply that GeoGebra-based training can serve as an effective approach to developing prospective teachers' competencies within the TPACK framework, contributing to the advancement of technology-integrated mathematics education. However, this study is limited by constraints such as limited device availability and the relatively short duration of the training, which may affect the depth of skill mastery. Therefore, future programs are recommended to be conducted continuously and integrated into educational technology courses to ensure sustainability. Practically, teacher education institutions are encouraged to adopt structured GeoGebra training as part of their curriculum to better prepare prospective mathematics teachers who are adaptive to technological developments and capable of delivering engaging and meaningful learning experiences.

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