COMMUNITY SERVICE PROGRAM SUPPORTING SDG 4: STRENGTHENING COMPETENCIES OF PROSPECTIVE MATHEMATICS TEACHERS THROUGH DIGITAL WORKSHEET DEVELOPMENT TRAINING

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Abstrak: Program pelatihan pengabdian kepada masyarakat ini, yang dilaksanakan di luar perkuliahan rutin, dengan peserta mahasiswa yang tergabung dalam Himpunan Mahasiswa Pendidikan Matematika (HIMAPTIKA) Universitas Serang Raya, bertujuan untuk mengembangkan kompetensi mahasiswa calon guru matematika dalam merancang Lembar Kerja Siswa Digital (LKSD) berbasis aplikasi digital, sebagai kontribusi terhadap SDG 4 Pendidikan Berkualitas. Melalui sesi pelatihan yang melibatkan aplikasi seperti GeoGebra, PhET Interactive Simulation, dan Canva, peserta berlatih mengembangkan bahan ajar yang interaktif dan inovatif. Evaluasi dilakukan melalui dua pendekatan: evaluasi formatif (tugas praktis, observasi, dan umpan balik harian) dan evaluasi sumatif (produk akhir LKSD dan kuesioner). Hasil menunjukkan bahwa peserta mengalami peningkatan dari keterampilan digital yang terbatas sebelum program menjadi kompetensi dan kepercayaan diri yang lebih baik setelahnya, meskipun masih terdapat tantangan dalam merancang LKSD yang lebih kompleks. Program ini juga berhasil membangun kepercayaan diri peserta dalam menggunakan teknologi untuk pembelajaran serta memberikan dampak positif terhadap keterlibatan mereka dalam pendidikan matematika. Secara keseluruhan, pelatihan ini menunjukkan potensi yang kuat untuk meningkatkan kualitas pendidikan matematika dengan memberdayakan calon guru agar mampu mengintegrasikan teknologi secara efektif dalam pembelajaran.

Kata Kunci: integrasi teknologi pendidikan, kompetensi guru matematika, lembar kerja siswa digital, SDG 4, program pelatihan guru

Abstract: This community engagement training program, conducted outside routine classroom lectures, with participants consisting of students from the Mathematics Education Student Association (Himpunan Mahasiswa Pendidikan Matematika/HIMAPTIKA) at Universitas Serang Raya, aims to enhance the competencies of prospective mathematics teachers in designing Digital Student Worksheets (DSWs) using digital applications, contributing to SDG 4 Quality Education. Through training sessions involving applications such as GeoGebra, PhET Interactive Simulations, and Canva, participants practiced and improved their skills in developing interactive and innovative teaching materials. Evaluation was conducted through two approaches: formative assessment (practical tasks, observations, and daily feedback) and summative assessment (final DSW products and questionnaires). Results showed that participants improved from limited prior digital skills to enhanced competencies and stronger confidence afterward, although some challenges remained in designing more complex worksheets. The program also successfully built participants' confidence in using technology for teaching and had a positive impact on their engagement in mathematics education. Overall, this training demonstrates strong potential to improve the quality of mathematics education by empowering pre-service teachers to integrate technology into teaching and learning effectively.

Keywords: educational technology integration, digital student worksheets, mathematics teacher competency, teacher training program, SDG 4

Introduction

Quality education is a critical component in achieving the Sustainable Development Goals (SDGs), particularly SDG 4 – Quality Education, which focuses on providing inclusive, equitable, and quality education (Tonegawa, 2023). A quality education is expected to enhance lifelong learning opportunities for all. In this context, the role of teachers, particularly prospective mathematics teachers, is crucial in creating learning experiences that are relevant to the times, especially with the integration of digital technology in education (Buentello-Montoya et al., 2021; Engelbrecht & Borba, 2024; Lavidas et al., 2022; Viberg et al., 2023).

However, observations at various universities in Indonesia have revealed a gap in prospective mathematics teachers' ability to develop technology-based teaching materials. Many of them lack sufficient understanding of how to use relevant digital applications for mathematics teaching, such as GeoGebra, PhET Interactive Simulation, and Canva. Preliminary surveys confirmed this gap, showing that over 70% of participants had never used GeoGebra or PhET in their coursework prior to the program. This gap leads to a lack of competence in developing interactive, engaging, and diverse teaching materials that accommodate various student learning styles (Boysen, 2024; El-Sabagh, 2021). This gap also indicates that while the mathematics teacher education curriculum focuses on foundational mathematics theory, practical skills in using technology to design effective and creative Digital Student Worksheets (DSWs) are often overlooked.

Previous literature indicates that the use of digital applications in mathematics education has a significant impact on enhancing students' understanding of mathematical concepts (Engelbrecht & Borba, 2024; Viberg et al., 2023). Applications like GeoGebra allow students to conduct visual experiments in geometry, algebra, and calculus, which reinforce their understanding of abstract mathematical concepts (Bekene Bedada & Machaba, 2022; Birgin & Uzun Yazıcı, 2021). PhET Interactive Simulation helps students understand the relationship between functions and graphs through interactive graphical platforms (Banda & Nzabahimana, 2021; Oktaviyanthi & Sholahudin, 2023). Canva enables the creation of visually engaging DSWs by combining text, images, and graphics into interactive designs that support the learning process (Boukid, 2022; Mpungose & Khoza, 2022). Although these applications are increasingly used in mathematics teaching, their use in training prospective mathematics teachers remains limited.

Despite the growing body of research on digital applications in mathematics classrooms, there remains limited empirical evidence on their systematic integration into pre-service teacher training, particularly within the Indonesian context. Several studies show that training for prospective mathematics teachers in the use of digital technology remains insufficient, leaving them unprepared to design digital, application-based teaching (Ayanwale et al., 2024; Guran et al., 2022; Makarova et al., 2023; Stavermann, 2024). Therefore, this research and community service aim to address this gap by providing training to prospective mathematics teachers on how to develop and utilize digital application-based DSWs in mathematics teaching.

Based on the literature review, the development of digital DSWs tailored to applications has the potential to increase student engagement in mathematics learning and introduce them to technology relevant to daily life. Therefore, the goal of this community service is to facilitate the development of competencies among prospective mathematics teachers in designing digital application-based DSWs. This training is expected to equip prospective teachers with practical skills to create innovative, technology-based learning materials that align with current demands and the development of knowledge.

The novelty of this program lies in integrating service-learning and participatory action research (PAR), which are rarely combined in teacher-training initiatives in Indonesia. This approach ensures not only skill development but also reflective practice and sustainable community engagement. This training is anticipated to significantly support the achievement of SDG 4: Quality Education by empowering prospective teachers to create more inclusive, technology-based, and high-quality education. The training aims to strengthen prospective teachers' competencies in designing effective, engaging, and relevant mathematics learning experiences, as well as helping them optimize the use of digital applications in developing LKS that align with the demands of 21st-century education.

Methods

This community service adopts a Service-Learning approach combined with Participatory Action Research (PAR). This approach was chosen because it integrates practical learning for participants with research implementation that provides solutions to the problems they face, while also directly impacting the development of prospective mathematics teachers' competencies (Resch & Schrittesser, 2023; Velotti et al., 2022). Service Learning enables students to actively apply the knowledge and skills they learn in real-world contexts, while PAR provides an opportunity for collaborative reflection on the practices carried out for continuous improvement. A community service program was chosen to address this urgent need because participants required immediate practical skills development, whereas curriculum redesign would involve a longer institutional process.

Methodological Steps

The first step in this community service is identifying the problems faced by prospective mathematics teachers in developing digital application-based Digital Student Worksheets (DSWs). Preliminary research was conducted through observations of prospective teachers at Universitas Serang Raya and interviews with lecturers teaching mathematics education courses. Preliminary surveys confirmed that more than 70% of the participants had never used GeoGebra or PhET in their coursework prior to the program. Initial findings indicated that most prospective teachers lacked the skills to use digital applications to create interactive DSWs that meet students' needs in the digital era.

Based on the problem analysis, the problem formulation for this community service is how to facilitate the development of prospective mathematics teachers' abilities to design digital application-based DSWs. The objective of this service is to provide training focused on developing practical skills in designing and using digital applications to create interactive, effective, and engaging DSWs for students. The participants were 30 fifth-semester students from the Mathematics Education Program at Universitas Serang Raya, members of the Mathematics Education Student Association (Himpunan Mahasiswa Pendidikan Matematika/HIMAPTIKA).

The training program is designed to involve prospective mathematics teachers as the primary subjects. The training consists of several sessions, starting with an introduction to digital applications that provides a basic understanding of the tools used to create DSWs. This is followed by training on using these applications, teaching technical skills for designing DSWs, including the use of graphical features, diagrams, and mathematical visualizations. Participants are then tasked with creating DSWs that incorporate interactive elements using the applications learned. The final session includes a trial run and feedback, during which participants will test creating DSWs with simulated student groups and receive feedback from mentors and peers.

To measure the training's success, ongoing evaluation is conducted. Formative evaluation occurs during training through practical tasks, group discussions, and direct participant feedback. Summative evaluation is conducted at the end of the training by assessing participants' competencies in creating digital DSWs based on the DSWs products they have created. In addition, participants are asked to fill out questionnaires about their understanding of digital applications and the impact on their teaching abilities. Success indicators were established to ensure replicability of the methodology: quantitatively, participants were expected to achieve an average score of ≥ 4 on the competency rubric; qualitatively, interviews confirmed that participants reported increased confidence in using digital applications for teaching.

After the training is completed, participants are asked to provide feedback on the training program, including any difficulties encountered, the features that were most helpful, and suggestions for improvement. Based on this feedback, the training program will be refined for future sessions. Follow-up support will also be provided for several months after the training to ensure that participants can effectively apply what they have learned in real teaching contexts.

The methodological workflow, as illustrated in Figure 1, summarizes these steps in a sequential flow. It begins with observation and problem identification, followed by problem formulation and setting objectives. The next phases involve designing and implementing the training program, conducting evaluations, gathering feedback, and providing follow-up support to participants to ensure the sustainability of the skills acquired during the training. This integrated approach ensures that the training effectively equips prospective mathematics teachers with the competencies needed to design interactive, application-based LKS while continuously improving the program through feedback and evaluations.

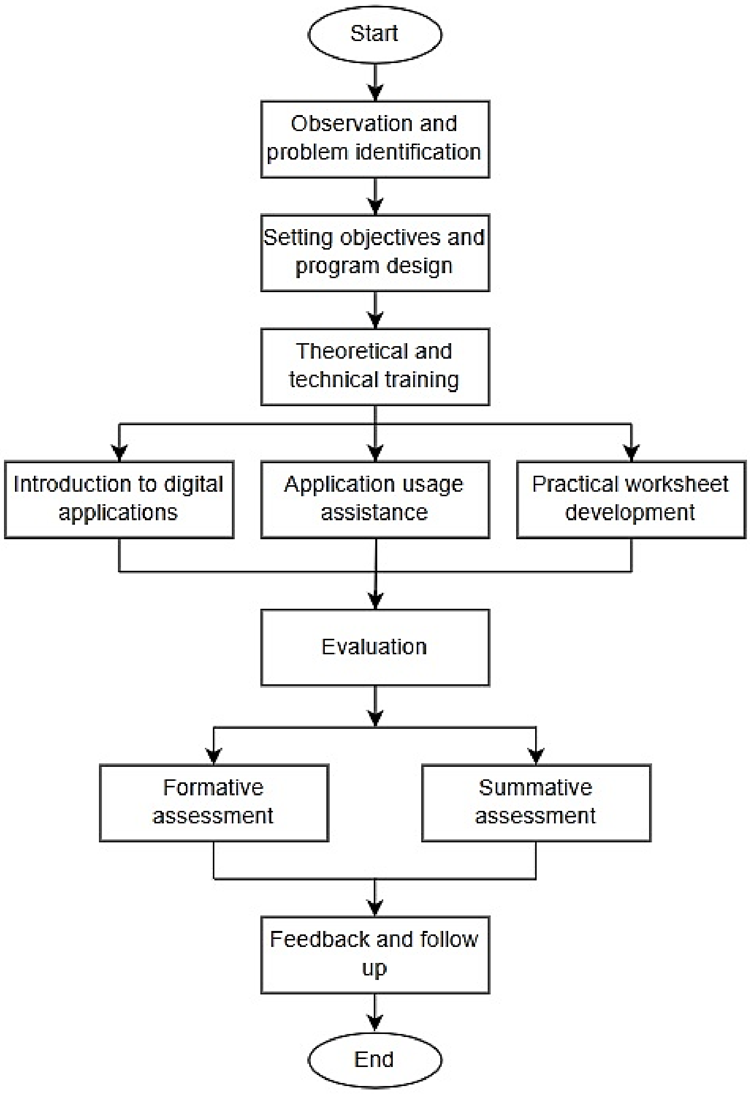

Figure 1. Workflow of the Community Engagement Program

Evaluation and Feedback

The effectiveness of the training was assessed through ongoing evaluations. Formative evaluation was conducted throughout the program through practical assignments, group discussions, and real-time participant feedback. Summative evaluation was carried out at the end of the program by assessing participants' competencies in creating digital application-based LKS through an evaluation of the LKS they developed. Additionally, participants completed questionnaires to gauge their understanding of digital applications and the impact on their teaching skills.

Upon completing the training, participants provided feedback on the program, including the challenges they faced, the most beneficial features, and suggestions for improvement. This feedback was used to refine subsequent training sessions. Follow-up support was provided for several months post-training to ensure that participants could effectively apply the knowledge and skills gained in real teaching contexts.

Data Analysis

The data obtained from this training consists of qualitative and quantitative data. Qualitative data were collected from interviews and discussions with participants to understand their perspectives on the use of digital applications in mathematics education. This data was analyzed using thematic analysis to identify patterns and challenges participants encountered (Morgan, 2023). To enhance reliability and validity, two researchers independently coded 20% of the qualitative data, and discrepancies were resolved through discussion to ensure inter-coder reliability. Meanwhile, quantitative data were collected through questionnaires and assessments of participants' competencies in using digital applications to create DSWs (Onwuegbuzie & Johnson, 2021). This data was analyzed descriptively to describe the level of competency participants demonstrated during the training. Participants' academic background was also considered; they were mathematics education students in at least their fourth semester, meaning they had completed core mathematics content courses but had not yet received formal training in technology integration, which influenced both their baseline skills and the program's outcomes.

Results and Discussion

The main activity in this community service program was an intensive training session designed to support the development of prospective mathematics teachers' competencies in designing digital application-based Digital Student Worksheets (DSWs). This training was implemented in phases, starting with the introduction to digital applications, followed by technical training in application use, and culminating in DSW creation practice.

The training began with an introduction to digital applications, including GeoGebra, PhET Interactive Simulations (see Figure 2), Desmos, and Canva. In this session, participants learned about the functions, features, and benefits of these applications for teaching. Not only did they listen to theoretical explanations, but they also engaged in simple practical tasks that immediately applied the material just presented. Participants' progress was monitored through observation notes that documented their enthusiasm for exploring new technologies.

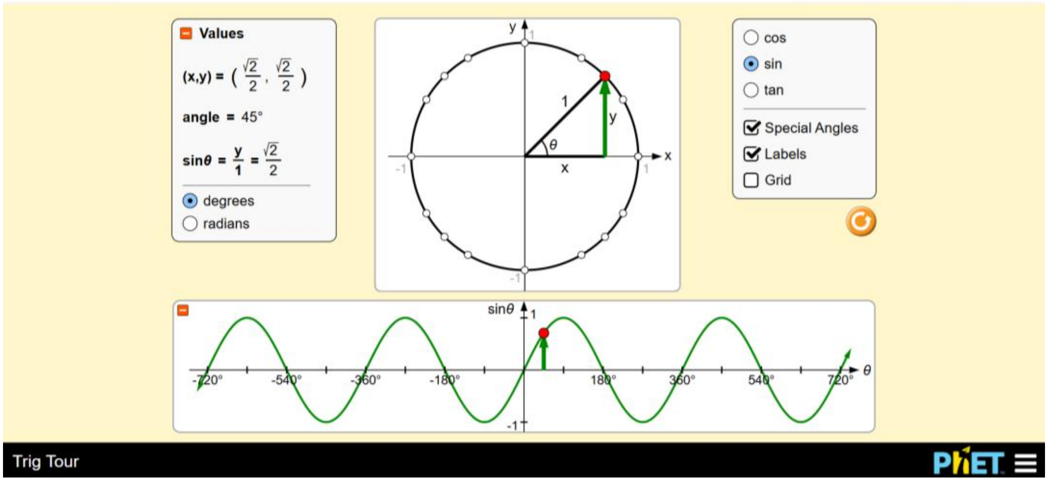

Figure 2. PhET Interactive Simulation Application

Following the introduction phase, the training progressed to a technical session focusing on the in-depth use of applications. Participants engaged in step-by-step demonstrations, hands-on practice, and received guidance in operating the key features of each application (see Figure 3). They were trained to create mathematical visualizations, interactive graphs, and aesthetically appealing elements, ensuring the DSWs developed were both effective and engaging. During this session, observers continuously recorded participants' technical progress, and daily feedback was collected to understand the challenges they faced. Their progress was measured through competency-based evaluations, which reflected the extent to which they comprehended and applied the newly acquired skills.

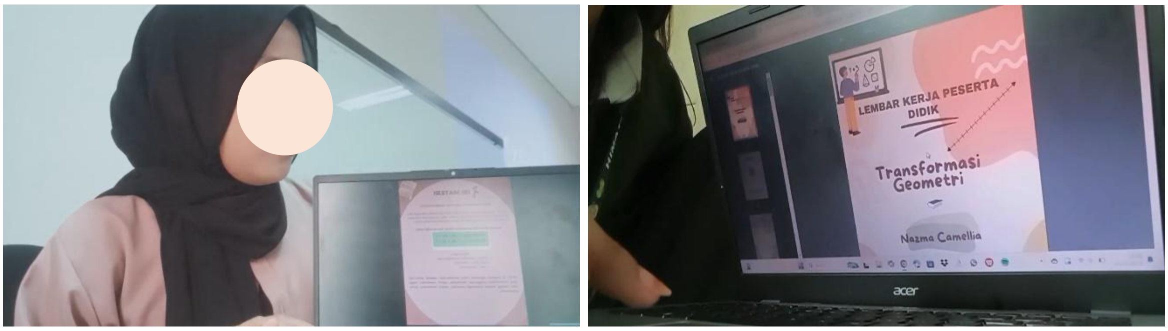

Figure 3. Technical Guidance in LKS Development

The final stage was the practical development of DSWs, during which participants were given autonomy to design products tailored to their individual teaching needs. They worked independently or collaboratively to create worksheets that creatively integrated technology with pedagogy. Mentors and peers subsequently evaluated the products to ensure their quality and relevance. Additionally, questionnaires were distributed to gather participants' perceptions regarding the training's benefits, while the final quality of their work was assessed through competency-based evaluation rubrics rather than conventional classroom tests. Data from this stage were analyzed to produce processed scores, including pre-test and post-test comparisons, indicating the participants' overall success in mastering the skills required to develop digital worksheets. Overall, this program provided a comprehensive learning experience and fostered participants' innovation in leveraging technology to support mathematics education.

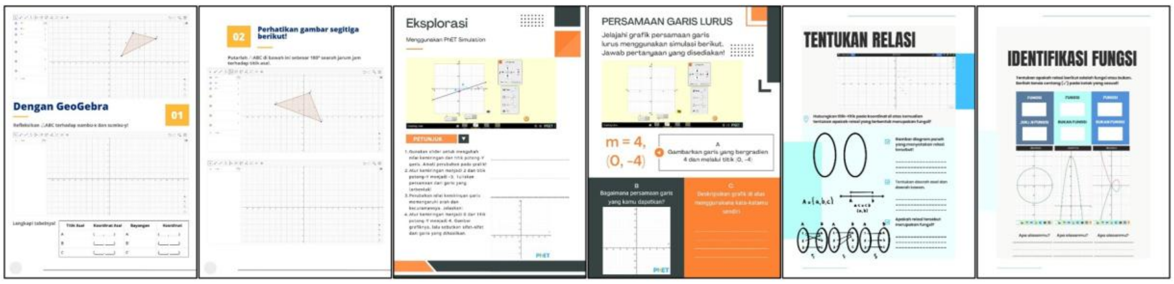

Figure 4. Excerpts of Digital Worksheets (GeoGebra, PhET Simulation, and Desmos)

After presenting the excerpts of participant-generated worksheets in Figure 4, the quantitative results of the competency-based evaluations are summarized in Table 1. The table reports mean scores, score ranges, and the percentage of participants reaching proficiency (≥

4) across different evaluation aspects. This processed presentation replaces raw scores to highlight overall trends, learning gains, and areas where participants excelled or required additional support.

Table 1. Summary of Competency-Based Evaluation Results

Evaluation Aspect	Mean Score	Score Range	% Participants (≥ 4)	Key Notes
Practical Tasks	4.27	3 – 5	80%	Most participants successfully completed the assigned practical tasks.
Observation Notes	4.10	3 – 5	77%	High enthusiasm, though some remained passive in the early sessions.
Daily Feedback	4.37	3 – 5	83%	Participants were active in providing feedback and engaging in discussions.
Formative Average	4.19	3.33 – 5	83%	Strong mastery of structured, guided activities.
DSW (Worksheet) Evaluation	4.10	3 – 5	73%	Higher quality observed with additional practice/iterations.
Questionnaire	3.90	3 – 5	63%	Confidence improved; some technical issues remained.
Summative Average	4.02	3 – 5	63%	Slightly lower than formative; final products required more independence.

Table 1 shows that participants performed strongly in practical tasks, observation notes, and daily feedback (means above 4.0, with more than 80% scoring ≥ 4). This result indicates that the training structure and scaffolded activities effectively supported participants in acquiring core digital competencies. However, the questionnaire and DSW evaluation scores were relatively lower (means around 3.9–4.1, with 63–73% ≥ 4). This gap suggests that while participants understood and practiced the tools during guided sessions, translating these skills into independent product design and sustained confidence remained more challenging. The difference between the formative (4.19) and summative (4.02) averages confirms this trend, highlighting the need for additional practice time and mentoring to consolidate advanced skills.

Quantitative Evaluation Results

The implementation of this program aimed to strengthen the competencies of prospective mathematics teachers in developing digital application-based DSWs. Evidence of impact is presented through before-and-after comparisons: prior to the program, more than 70% of participants had never used GeoGebra or PhET; after the training, post-test results and rubric evaluations confirmed significant improvement in their ability to design interactive worksheets and their confidence in using technology. An illustration of the formative and summative evaluation results is presented in Figure 5, while the detailed outcomes are explained below.

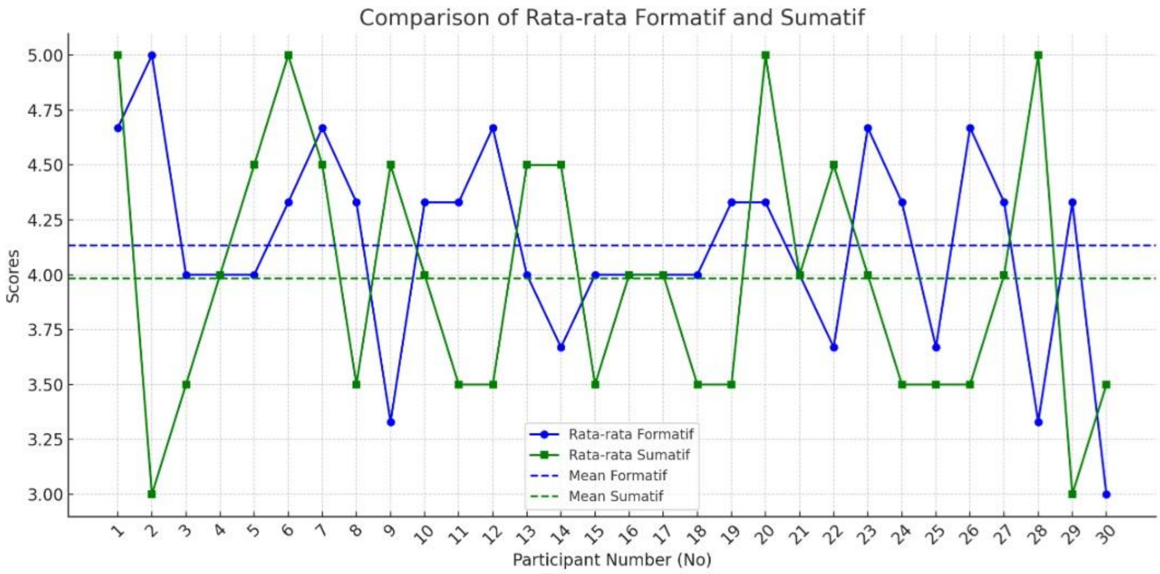

Figure 5. Training Evaluation Graph (Formative vs Summative)

The graph shows that formative scores were consistently higher than summative scores, leading to the following detailed analysis.

1. Formative Evaluation

The average formative score across all participants was 4.19, indicating that most participants were actively engaged during the training process. Formative evaluation focused on daily activities, such as completing practical assignments, participating in group discussions, and contributing to observation and feedback sessions. A total of 83.33% of participants achieved a formative score of ≥ 4, which demonstrates that the majority successfully grasped the use of digital applications for mathematics instruction, including GeoGebra, PhET interactive simulation, and Desmos. These high formative scores reflect participants' ability to adapt to technology-based learning methods and improve their skills through the structured steps provided during the training.

2. Summative Evaluation

The average summative score among participants was 4.02, slightly lower than the formative average. Summative evaluation emphasized participants' ability to apply their skills through the final product, namely creating digital application-based DSWs, as well as their responses to a questionnaire assessing their level of understanding. A total of 63.33% of participants obtained a summative score of ≥ 4, suggesting that more than half successfully applied the knowledge and skills learned during the training. However, some participants achieved lower scores, which may be attributed to technical challenges, limited time, or a lack of confidence in designing complex final products. These variations indicate the additional challenges participants faced in translating theoretical learning and practical exercises into optimal final outcomes.

3. Pre–Post Effectiveness

To further demonstrate program effectiveness, pre-test and post-test comparisons were conducted on three indicators: digital competency, self-confidence, and technology integration. As presented in Table 2, all three showed clear improvement, with gains of +1.20 to +1.25 points.

Table 2. Pre-test vs Post-test Comparison

Aspect	Pre-test Mean	Post-test Mean	Improvement (Gain)
Digital Competency	2.85	4.05	+1.20
Self-Confidence	2.90	4.10	+1.20
Technology Integration	2.70	3.95	+1.25

Table 2 demonstrates clear evidence of the program's effectiveness. All three aspects, digital competency, self-confidence, and technology integration, showed meaningful gains of +1.20 to +1.25 points from pre-test to post-test. These improvements indicate that the training successfully reduced the initial skills gap, as prior to the program, more than 70% of participants had never used GeoGebra or PhET. Post-training, participants not only mastered basic digital functions but also reported stronger confidence in applying these tools to lesson design. The most significant gain was in technology integration (+1.25), suggesting that participants became more capable of embedding digital applications into pedagogical contexts. This finding supports the claim that the training contributed directly to bridging the gap between theoretical coursework and practical technology-based teaching.

Interview Results

To gain deeper insights into participants' understanding, challenges, and perceptions of using digital applications in mathematics education, interviews and discussions were conducted with the training participants (see Figure 6).

Figure 6. Interviews and Discussions

The interview results provided valuable insights into their experiences during the training, including technical aspects and attitudes toward technology. Several key themes emerged from the analysis of the interviews, including participants' understanding of digital applications, technical challenges faced, behavioral changes, and increased confidence in using technology for teaching. Table 3 below summarizes the interview and discussion results conducted with the participants.

Table 3. Interview and Discussion Results

Theme	Before Training (Condition)	After Training (Evidence)	Example Participant Statement
Understanding of Applications	Limited to basic use; unable to handle complex simulations	Improved ability to apply advanced features, though challenges remain	"I know how to use GeoGebra to draw graphs, but it's difficult to create more complex mathematical simulations." (P3)
Infrastructure Challenges	Connectivity issues hindered active participation	Participants learned alternative strategies, but connectivity remains a barrier	"Unstable internet connectivity made it difficult for me to follow some exercises that required direct online access." (P7)
Need for Practice and Guidance	Unfamiliar with digital applications; lacked confidence	Requested extended practice sessions and mentoring for mastery	"I need more time to practice the material and intensive guidance to solve emerging technical problems." (P10)
Application Relevance in Teaching	Found the tools interesting, but could not link them to class contexts	Better awareness of relevance, though integration into classroom is still a challenge	"I find the applications taught quite interesting, but I struggle to connect them to classroom learning." (P12)
Application Use Skills	Very limited visualization skills	Able to use GeoGebra to visualize concepts effectively	"Using GeoGebra greatly helps in visualizing mathematical concepts." (P5)
Confidence in Using Technology	Low self-confidence in digital tools	Reported increased confidence in using technology in teaching	"I am now more confident using technology in the classroom, although there are still some areas for improvement." (P20)

Table 3 provides a summary of participants' experiences, both in terms of technical aspects and attitudes toward technology use. It contrasts their conditions before and after the program. Prior to the training, many participants reported limited familiarity with digital applications, difficulties in linking tools to classroom contexts, and low confidence in using technology. Following the training, they demonstrated greater awareness of application features, recognized the pedagogical relevance of digital tools, and expressed improved confidence in applying them for teaching.

Additionally, several participants expressed a need for more practice time and mentoring to enhance their technical skills, especially in addressing application and infrastructure issues. Nevertheless, some participants reported significant improvements in their confidence in using technology, highlighting the positive impact of the training program on their attitudes and perceptions toward technology in mathematics education.

Discussion

Skill Mastery Level

The results of this training program indicate that the sessions successfully equipped pre-service mathematics teachers with the necessary skills to utilize digital applications in mathematics education. High formative assessment scores reflect the participants' ability to comprehend and implement fundamental concepts in using applications such as GeoGebra and PhET Interactive Simulations. These findings align with the principles of practice-based learning theory, which emphasize that active engagement in hands-on activities is more effective for skill development than passive methods such as lectures (Al Shloul et al., 2024; Kholid et al., 2023). Some of the group discussions during the training reinforced collaborative abilities, which are critical skills for 21st-century learning.

However, while many participants mastered the basics of digital application use, some technical challenges and difficulties with advanced understanding persisted. As evidenced by interviews (Table 3), several participants expressed difficulties in applying the applications to more complex tasks. One participant stated, *"I know how to use GeoGebra to draw graphs, but it's challenging to create more complex mathematical simulations"* (Participant 3). This statement suggests that while participants acquired foundational skills, advanced application requires further guidance and experience.

Challenges in Developing Digital Worksheets (DSWs)

Summative evaluation results revealed that although participants demonstrated proficiency in using digital applications, some still faced challenges in designing high-quality digital worksheets (LKS). These difficulties included creating engaging designs, integrating interactive elements, and addressing technical constraints, such as device access and internet connectivity. Such challenges are consistent with those reported by other community service programs in Indonesia, which have also encountered similar obstacles in supporting pre-service teachers' digital literacy (Wattimena et al., 2024; Tambunan & Tambunan, 2022; Yamin et al., 2023). These challenges underscore the need for additional support, particularly in the technical and aesthetic aspects of LKS design. Consequently, future training curricula should include more in-depth practice sessions and technology-based teaching simulations to enhance the effective application of these skills.

One of the technical challenges participants encountered was related to infrastructure. As noted by one participant (Table 3), "*Unstable internet connectivity made it difficult for me to follow some exercises that required direct online access*" (Participant 7). This issue highlights that while technical skills can be developed, external factors such as infrastructure and hardware remain obstacles that need to be addressed to maximize program effectiveness.

Impact on Participants' Behavioral and Mindset Changes

The training program positively influenced participants' behavior and mindset. Prior to the training, many were hesitant or even reluctant to use technology in their teaching. However, post-training results indicated that they felt more confident in designing and utilizing digital applications as teaching tools. This outcome underscores the importance of technology-based training in building educators' confidence to incorporate technology into the teaching-learning process (Engelbrecht & Borba, 2024; Viberg et al., 2023). This newfound confidence contributes to the broader adoption of technology in educational settings, supporting technology-enhanced learning as part of the educational revolution in the digital era.

Interviews (Table 3) revealed that many participants experienced increased confidence in their technology use. One participant noted, "*I am now more confident using technology in the classroom, although there are still some areas that need improvement*" (Participant 20). This increase in confidence indicates that the training positively influenced participants' mindsets, though there remains room for improvement.

Addressing the Skill Gap

The training effectively addressed the primary issue identified earlier, the skill gap among pre-service mathematics teachers in using technology. Before the program, more than 70% of participants had never used GeoGebra or PhET in their coursework. Through this initiative, they not only acquired technical skills but also gained insights into how technology can enhance the quality of instructional materials. Thus, the training bridged the skill gap and supported the achievement of Sustainable Development Goal (SDG) 4 on quality education, which emphasizes the importance of integrating technology into education (Saini et al., 2023; Tonegawa, 2023).

However, some participants still struggled to connect application use with classroom teaching. As one participant remarked (Table 3), "*I find the applications taught quite interesting, but I struggle to link them with classroom teaching*" (Participant 12). This struggle highlights that while technical skills can be mastered, effectively integrating technology into broader teaching contexts remains a challenge.

Enhancing the Quality of Learning

The quality of learning that improved through this program was the pre-service mathematics teachers' own. Measured through competency rubrics, pre–post tests, and qualitative interviews, the training enhanced their ability to design interactive DSWs and increased their confidence in using digital applications. With more interactive and dynamic worksheets, participants can actively engage their own students in future classroom practice, aligning with constructivist theory that emphasizes student-centered learning (Rivas et al., 2022; Sharples et al., 2020). In the long term, this transformation can shift mathematics instruction from conventional methods to more innovative approaches that align with students' needs in the digital era.

Participants also acknowledged the benefits of using applications to clarify mathematical concepts. For instance, one participant stated (Table 3), "*Using GeoGebra greatly helps in visualizing mathematical concepts*" (Participant 5). This statement underscores how digital applications can aid in understanding abstract concepts and improving comprehension of mathematical material.

Overall, the revised Discussion demonstrates that the program succeeded in equipping participants with technical skills, fostering positive mindsets toward technology, and addressing skill gaps. At the same time, it critically acknowledges the challenges, situates them within the context of similar programs in Indonesia, and highlights implications for curriculum redesign and continuous mentoring. With these refinements, the program can contribute more significantly to promoting high-quality, technology-driven learning environments in mathematics teacher education.

Conclusion

This community engagement program successfully equipped prospective mathematics teachers with the competencies to design digital student worksheets (DSWs) using applications such as GeoGebra, PhET Interactive Simulations, and Canva. The training enhanced both their technical skills and confidence in integrating technology into mathematics teaching, which had previously been perceived as challenging. Overall, the program contributed significantly to supporting SDG 4 – Quality Education by empowering pre-service teachers to create more interactive and technology-driven learning materials. While some challenges remain in broader classroom application, the training laid a strong foundation for future improvement.

To maximize its impact, it is recommended to expand the program to a broader group of pre-service teachers and to provide continuous mentoring. With such follow-up, the initiative can play a key role in transforming mathematics education toward more inclusive, engaging, and technology-enhanced practices. Future research should explore the long-term impact of such training on actual classroom practices, its scalability across diverse educational contexts, and the integration of more advanced digital tools. A longitudinal study would also be valuable to examine how the skills gained are sustained and translated into teaching performance over time.

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