STEM and Ethnomathematics: Innovations in Mathematics Learning at Banyuasin Junior High Schools

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Abstract

Many mathematics teachers in rural areas still lack access to contextual and culturally relevant digital teaching resources. This community service activity aims to improve the understanding and skills of mathematics teachers at Banyuasin Junior High School in developing digital teaching materials based on Science, Technology, Engineering, and Mathematics (STEM) and ethnomathematics. Through a needs analysis conducted with a questionnaire, it was revealed that only 25% of teachers were familiar with ethnomathematics and 30% with STEM principles. The training and mentoring program took place from August to October 2024, attended by 22 teachers, with interactive methods that included workshops, group discussions, and hands-on practice. Evaluation results showed that 84.5% of participants were satisfied with the training, and there was a significant improvement in their understanding and skills in developing digital teaching materials. However, there is still a need for more practice time and concrete examples of the application of ethnomathematics. It is recommended to conduct continuous training, provide additional resources and build collaborative networks between teachers. As a result of this activity, the quality of mathematics teaching at Banyuasin Junior High School has shown improvement through the development of more relevant and contextualized teaching materials

Keywords

Contextual mathematics learning; Digital teaching material; Ethnomathematics; STEM education; Teacher professional development

Introduction

Effective mathematics education is essential in equipping students with 21st-century skills and problem-solving abilities required in the digital era (Moreno-Armella & Hegedus, 2014; Wijers & de Haan, 2020). The implementation of Science, Technology, Engineering, and Mathematics (STEM) concepts in mathematics

instruction can enhance students' understanding in a more contextual and applicable manner (Schreiter et al., 2022). Integrating local cultural values into mathematics education is also an alternative approach to achieving more effective mathematics learning (Utari et al., 2024). Combining STEM with ethnomathematics—which emphasizes local cultural values—can create more relevant and engaging learning experiences for students.

The integration of ethnomathematics into teaching materials is crucial for making mathematics more accessible and understandable to students. Ethnomathematics connects mathematical concepts with students' cultural practices and experiences, thus fostering a more inclusive learning environment. Mathematics learning based on ethnomathematics can significantly enrich students' experiences by providing culturally relevant contexts aligned with their backgrounds (Rauf et al., 2022; Sari & Putri, 2021; Utari, 2017). This approach not only supports conceptual understanding but also fosters a sense of identity and ownership among students, which is vital to their academic success (Amaliyah, 2024; Deda & Disnawati, 2024). In addition to ethnomathematics, the integration of STEM education into mathematics teaching is increasingly recognized as essential in preparing students to face future challenges. Studies show that STEM education positively impacts students' mathematics achievement, problem-solving skills, and overall attitudes toward learning (Schreiter et al., 2022). Integrating ethnomathematics and STEM represents a theoretically grounded and contextually responsive strategy to promote meaningful, equitable, and future-oriented mathematics learning.

The urgent need to develop mathematics teaching materials that integrate both STEM principles and ethnomathematics for junior high school (SMP) teachers is emphasized by various demands and trends in contemporary education, which include methods, practices, and theories relevant to current challenges and needs (Kemdikbud, 2022a; Kemdikbud, 2022b). This urgency is further reinforced by the necessity for teachers to adapt their pedagogical practices to meet the demands of 21st-century education. Professional development programs focusing on STEM integration have proven effective in enhancing teachers' confidence and competence in delivering an integrated curriculum (Debeş, 2018; Lesseig et al., 2016). This is particularly important for junior high school teachers, who play a key role in shaping students' attitudes toward mathematics and STEM fields. By equipping teachers with STEM-based

ethnomathematics teaching materials, we can support them in delivering lessons that are not only mathematically rigorous but also culturally relevant and engaging.

A preliminary survey conducted among teachers participating in the Banyuasin Junior High School Mathematics Teachers Association (MGMP) revealed that only around 20% had heard of or were familiar with ethnomathematics and STEM. Although most teachers recognized the importance of cultural context in education, their specific knowledge of ethnomathematics as a pedagogical approach that connects mathematical concepts to local cultural practices remains limited. This indicates the need to enhance teachers' understanding and awareness of ethnomathematics so that they can integrate it into their teaching to create more meaningful learning experiences for students.

Therefore, the aim of this community service activity is to provide training and mentoring for MGMP mathematics teachers in Banyuasin in developing digital teaching materials that integrate STEM principles and are based on ethnomathematics. Through this program, it is expected that teachers will be able to understand and apply an approach that connects mathematical concepts with local cultural contexts, thereby making lessons more relevant and engaging for students. By leveraging digital technology, the resulting teaching materials are expected to not only improve students' understanding of mathematics but also enrich their learning experiences while fostering awareness of the cultural values around them.

Methods

The implementation method for this community service activity, which involved training and mentoring the Mathematics Teachers Association (MGMP) of junior high schools in Banyuasin in developing digital teaching materials using STEM and ethnomathematics-based approaches, consisted of several stages. Figure 1 below illustrates the method of implementation.

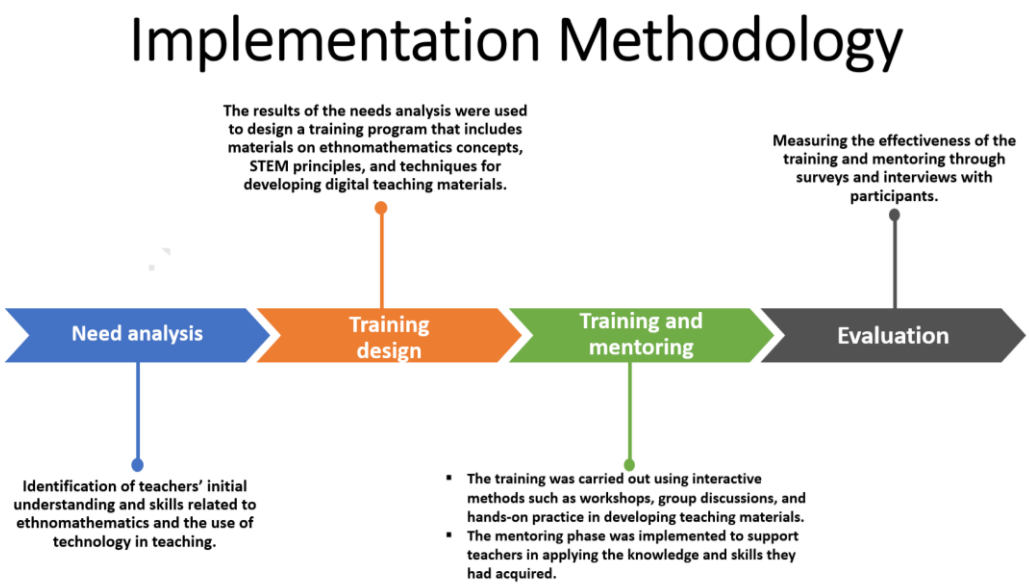

Figure 1. Method of Implementation

Based on Figure 1, the first stage of the implementation was needs analysis. This stage involved identifying the teachers' initial understanding and skills related to ethnomathematics and the use of technology in teaching. The analysis was conducted through a survey distributed via Google Forms and shared through WhatsApp groups.

The next stage was training design, which was developed based on the results of the needs analysis. The training content included materials on ethnomathematics concepts, STEM principles, and techniques for developing digital teaching materials.

Following the design phase, the training implementation stage was carried out using interactive methods such as workshops, group discussions, and hands-on practice in creating teaching materials. During this phase, participants were also encouraged to collaborate and share their experiences, fostering a productive learning environment.

After the training, the mentoring stage was conducted to support teachers in applying the materials they had learned. This stage included feedback sessions, evaluation, and technical assistance in the development of digital teaching materials.

Finally, an evaluation stage was conducted to assess the effectiveness of the training and mentoring through surveys and interviews with participants. The results of the evaluation were used to improve and refine future programs and to identify the impact of the community service activity on enhancing teachers' competencies in designing relevant and innovative teaching materials.

Result and Discussion

1. Needs Analysis

The needs analysis was conducted to identify the teachers' initial understanding and skills related to ethnomathematics, STEM, and the use of technology in teaching. Data was collected using questionnaires distributed to the Mathematics Teacher Working Group (MGMP) of junior high schools in Banyuasin.

First, the results indicated that teachers' understanding of ethnomathematics was still limited. Only around 25% of teachers reported having heard of or studied this concept, and the majority felt unfamiliar with how to integrate it into mathematics teaching. Although there was general awareness of the importance of cultural context in education, challenges arose when attempting to link mathematical concepts with local cultural practices.

Second, regarding STEM understanding, about 30% of teachers stated they were aware of STEM principles and the importance of integration in teaching, but only a few had applied them in the classroom. Many teachers expressed difficulties in designing activities that cohesively incorporate science, technology, engineering, and mathematics.

Third, in terms of technology use, about 50% of teachers reported using various digital tools, such as learning apps and social media, in their teaching. However, only a few felt confident in developing effective digital teaching materials. Most teachers expressed a need for additional training to master the required technical skills.

These findings highlight an urgent need for training programs focused on enhancing teachers' understanding of ethnomathematics and STEM, as well as their technical skills in using digital tools. This needs analysis serves as a crucial foundation for designing the training and mentoring program implemented in this community service activity.

2. Training Design

The training and mentoring program for developing digital teaching materials using STEM and based on ethnomathematics was designed to address the identified needs. The program aimed to improve teachers' understanding and skills in integrating

ethnomathematics concepts and STEM principles into engaging and interactive instructional materials.

Based on team discussions, the training design was divided into several sessions. The initial session focused on introducing ethnomathematics and STEM principles. Participants discussed the importance of cultural context in mathematics instruction. This session also included case studies on ethnomathematics practices from various regions, intended to inspire teachers in developing culturally relevant teaching materials.

The next session involved practical workshops where teachers were trained to use software and applications for creating digital instructional materials. Participants worked in groups to develop learning modules that integrate STEM components with local cultural content, particularly from the Banyuasin area. This collaborative approach not only enhanced technical skills but also promoted the exchange of ideas and experiences among teachers.

The mentoring sessions were designed to follow the formal training. The community service team provided direct guidance as teachers began implementing the material they had learned. These sessions included periodic feedback, as well as technical support to help address any challenges during the development process.

The evaluation sessions were planned to assess the effectiveness of the training and mentoring. Surveys and interviews with participants were conducted to gather feedback on knowledge and skill improvement, as well as the program's impact on their teaching practices. The evaluation results were used to refine and enhance future training programs.

3. Training and Mentoring Implementation

The training and mentoring sessions for the Mathematics MGMP teachers in Banyuasin took place from August to mid-October 2024. The training was attended by 22 junior high school mathematics teachers from the region. Figures 2a and 2b illustrate the implementation of the community service program.

Figure 2a. Training on Ethnomathematics

Figure 2b. Training on STEM

The training was carried out using interactive methods designed to maximize participant engagement. It began with a workshop session where participants were introduced to the concepts of ethnomathematics and STEM principles through presentations and discussions. Group discussions followed, allowing teachers to share their teaching experiences and challenges in incorporating cultural elements into the mathematics curriculum.

In the hands-on session, participants collaborated in small groups to develop digital teaching materials. They learned to use relevant software and applications while applying ethnomathematics knowledge to content development. This collaborative

atmosphere encouraged participants to exchange ideas, experiences, and strategies, fostering a productive learning environment.

After the formal training, mentoring was conducted to support teachers in applying the materials they had learned. The mentoring took place both synchronously (via Zoom) and asynchronously (via WhatsApp Groups). These sessions included feedback opportunities, where teachers shared their developed materials and received input from facilitators (speakers/community service team) and fellow participants.

Figure 3. Mentoring session with MGMP teachers via Zoom

Technical support was also provided to help teachers overcome any difficulties during the development of digital teaching materials. Facilitators offered additional assistance through direct consultations and online platforms, ensuring that teachers felt supported throughout their learning process.

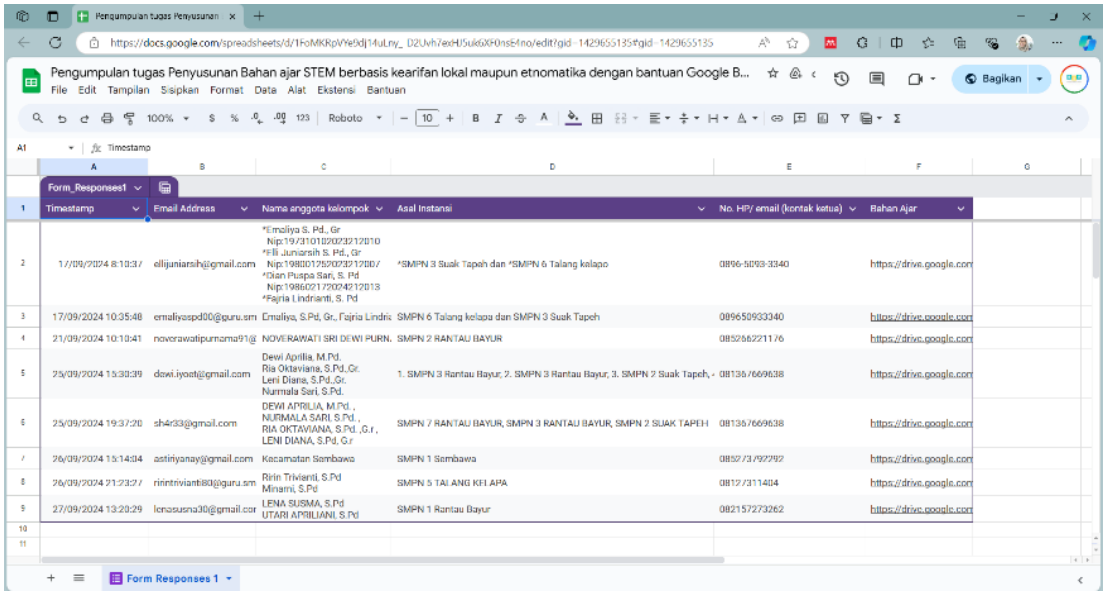

Figure 4. Google Drive folder for MGMP Teachers' Teaching Materials

This Google Drive folder contains the teaching materials produced collaboratively by the teachers during the mentoring phase. The content reflects their use of ethnomathematics based on the local cultural context of Banyuasin.

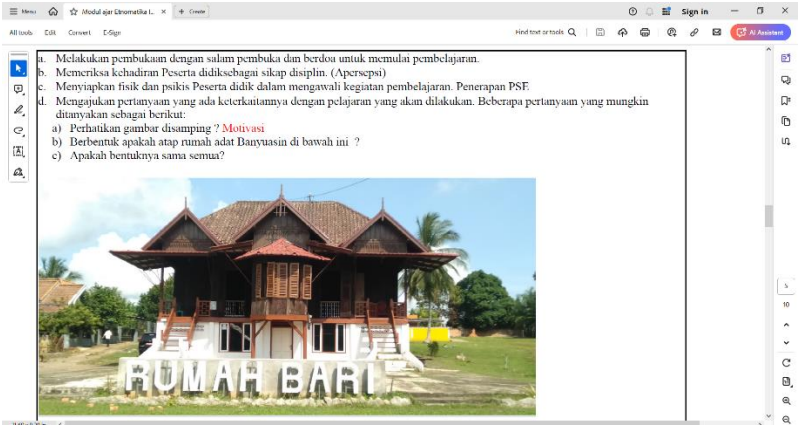

Figure 5. STEM-based Ethnomathematics Teaching Materials

4. Evaluation

The evaluation stage aimed to measure the effectiveness of the training and mentoring in helping teachers develop STEM-based digital teaching materials incorporating ethnomathematics. The evaluation involved surveys and interviews to gather data on participants' understanding, skills, and satisfaction with the program. Table 1 presents the survey results, based on a 4-point scale.

Table 1. Survey Results After Training and Mentoring

Survey Indicators	% Rated 3 or 4
Understanding	
a. Ethnomathematics concepts	82
b. STEM principles	78
c. Cultural-mathematical connection	87
Skills	
a. Developing digital materials	87
b. Use of technology	87
c. Teaching method implementation	82
Satisfaction	
a. Satisfaction with training	90
Overall Average	**84.5%**

The survey results indicate that approximately 84.5% of participants felt that the training provided new and relevant insights on ethnomathematics and STEM. Many teachers reported a significant boost in their confidence in using technology and their ability to integrate local cultural contexts into mathematics instruction.

From interviews, participants highlighted that the hands-on sessions and group discussions were the most valuable parts of the training, offering opportunities for collaborative learning and practical application. Several teachers also emphasized that the post-training mentoring was instrumental in helping them address technical and pedagogical challenges.

However, the evaluation also revealed areas for improvement. Some participants suggested allocating more time for practice sessions and providing more concrete examples of ethnomathematics implementation in local contexts. Others recommended a more structured training format, with additional sessions focused on technical aspects of software use.

The evaluation outcomes not only inform the improvement of future training programs but also provide insights into the impact of the initiative on teachers' professional development. Overall, this activity is expected to positively contribute to enhancing mathematics teaching quality in junior high schools in Banyuasin, through the development of more relevant and innovative teaching materials.

Discussion

The needs analysis revealed that teachers' understanding of ethnomathematics and STEM was still limited—only 25% were familiar with ethnomathematics and 30% with STEM principles. This gap indicates an urgent need for targeted capacity building, particularly considering the increasing importance of contextualized and future-oriented education in the Merdeka Curriculum (Kemdikbudristek, 2022a; 2022b). Despite general awareness of the need for cultural integration in teaching, many teachers still struggled to connect mathematical concepts with local practices, as also noted by Amaliyah (2024) and Deda & Disnawati (2024), who emphasized the value of ethnomathematics in enhancing cultural relevance in learning. Similarly, although 50% of teachers had utilized technology, their lack of confidence in designing digital teaching materials underscores the gap between access and pedagogical

competence—echoing findings by Moreno-Armella and Hegedus (2014) on the importance of digital literacy in educational practice.

To address these challenges, the training and mentoring program was systematically designed based on principles of effective professional development. The introduction of ethnomathematics and STEM, accompanied by practical case studies, aimed to raise awareness and provide concrete models, consistent with the strategies proposed by Utari et al. (2024) for integrating local wisdom into mathematics learning. The interactive format—through workshops, group discussions, and hands-on sessions—was aligned with the constructivist approach, which fosters learning through social interaction and contextual engagement (Wijers & de Haan, 2020). These methods created opportunities for teachers to collaboratively reflect on their practices, which is critical in changing instructional habits (Lesseig et al., 2016).

Post-training mentoring further supported the transfer of learning into classroom practice. The combination of synchronous and asynchronous mentoring ensured sustained engagement and accommodated teachers' schedules—an important factor in adult learning. This mentoring model reflects Debeş's (2018) conclusion that follow-up support enhances the long-term impact of STEM-related training.

The evaluation results indicate that the training had a positive effect on teachers' knowledge, skills, and attitudes. With 84.5% expressing satisfaction, the program demonstrated strong engagement and impact. These findings align with Schreiter et al. (2022), who emphasized the importance of interdisciplinary and culturally relevant strategies in promoting mathematical and statistical literacy. However, teachers' suggestions for more time to practice and clearer examples point to areas for further improvement. This is consistent with previous studies (e.g., Rauf et al., 2022; Sari & Putri, 2021), which highlight the need for iterative and context-rich instructional design to bridge the gap between abstract concepts and real-life contexts.

On the other hand, this program not only contributed to enhancing mathematics teaching in Banyuasin by integrating ethnomathematics and STEM, but also supported teachers' professional development in line with national educational goals (Kemdikbudristek, 2022a). The outcomes underscore the importance of culturally responsive pedagogy and technology integration in achieving equitable and quality mathematics education.

Conclusion

The needs analysis revealed that teachers' understanding of ethnomathematics and STEM was still limited, with only a small number feeling familiar with and capable of integrating these concepts into their teaching. The training and mentoring program conducted from August to October 2024 successfully improved participants' understanding, skills, and satisfaction. With 84.5% of teachers expressing satisfaction with the program, the training demonstrated a significant positive impact on the development of digital teaching materials based on ethnomathematics and STEM. However, there remains a need for more hands-on practice time and concrete examples of concept implementation, as well as suggestions for designing a more structured program in the future.

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