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Math Trace of a Million Flowers City: Learning Two-Dimensional using Ethno-RME and MathCityMap

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ABSTRACT

Penelitian terkait integrasi konteks budaya dan media digital dalam pendidikan matematika masih terbatas, sementara penelitian sebelumnya cenderung berfokus pada metode pengajaran tradisional, Ethnomathematics, dan Realistic Mathematics Education (RME) secara terpisah. Studi ini berusaha mengisi kesenjangan tersebut dengan menggabungkan pendekatan Ethnomathematics dan RME, yang dikenal sebagai Ethno-Realistic Mathematics Education (Ethno-RME), bersama teknologi MathCityMap. Tujuan utama penelitian ini adalah mengaplikasikan pendekatan matematika yang relevan secara budaya dalam skenario dunia nyata, dengan fokus pada peningkatan keterlibatan siswa dalam memahami bentuk geometris dua dimensi melalui pembelajaran berbasis pengalaman yang disusun dalam konteks budaya Alun-alun Magelang, Kota Sejuta Bunga. Penelitian ini menggunakan pendekatan *Design Research* tipe *Validation Studies*, yang mana data dikumpulkan melalui dokumentasi berupa foto, video, wawancara, dan lembar kerja siswa. Lintasan belajar yang dikembangkan didasarkan pada tiga aktivitas MathCityMap yang menunjukkan bahwa integrasi konteks budaya Alun-alun Magelang dengan pendekatan Ethno-RME dan MathCityMap secara signifikan berkontribusi terhadap pemahaman konseptual siswa tentang bentuk geometris dua dimensi. Temuan penelitian ini memberikan wawasan baru bagi pendidik, dengan memperkenalkan kerangka pedagogis yang menggarisbawahi pentingnya integrasi relevansi budaya dan teknologi dalam pembelajaran matematika.

Recent research addressing the integration of cultural contexts with digital tools in mathematics education remains scarce. Previous studies have predominantly focused on traditional teaching methods, ethnomathematics, and implementing Realistic Mathematics Education (RME) as distinct approaches. However, this study bridges a critical gap by combining Ethnomathematics and RME, referred to as Ethno-Realistic Mathematics Education (Ethno-RME), with MathCityMap technology. This innovative approach applies culturally relevant mathematics instruction to real-world scenarios. Specifically, the research enhances student engagement with two-dimensional geometric shapes through experiential learning set in the cultural context of Magelang Square in the City of Million Flowers. Employing a design research approach with a validation studies scenario, data were collected via photo and video documentation, interviews, and student worksheets. The study's learning trajectory is structured around three MathCityMap activities, demonstrating that integrating Magelang Square's cultural context with Ethno-RME and MathCityMap technology significantly improves students' conceptual understanding of two-dimensional shapes. These findings provide valuable insights for educators by introducing a novel pedagogical framework emphasizing the importance of cultural relevance and technological integration in mathematics education.

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INTRODUCTION

Mathematics has evolved through human endeavors to understand experiences, interpret phenomena, and develop solutions to real-world challenges (D'Ambrosio, 2007; Schoenfeld, 2022). Given its foundation in human reality, mathematics should naturally be an accessible and understandable discipline for all individuals (Utami et al., 2019; Hoffmann & Even, 2024). However, in formal education, mathematics is often taught in a highly abstract and formalized manner, which disconnects it from students' everyday experiences and sociocultural contexts, leading to perceptions of irrelevance (Alangui, 2017; de Abreu, 2020; Risdiyanti et al., 2024). As a result, despite its intrinsic ties to human experiences and practical problem-solving, mathematics education frequently appears detached from students' lived realities and cultural backgrounds.

In addition to the lack of connection to students' everyday experiences, mathematics education frequently emphasizes the direct teaching of formulas and problem-solving techniques, with insufficient focus on the process of mathematization or the varying cognitive abilities of students. This can result in difficulties in understanding fundamental concepts (Stacey, 2011; Goldin, 2020). Such an approach further intensifies students' struggles to recognize the practical applications of mathematics in addressing real-world issues (Bos, 2009; Alghiffari et al., 2024). Consequently, many students perceive mathematics as irrelevant, which contributes to the development of negative attitudes toward the subject (Drijvers, 2015; Robas et al., 2020; Büdenbender-Kuklinski et al., 2024). Thus, the emphasis on direct instruction over conceptual understanding often hinders students' comprehension and reinforces negative perceptions of mathematics.

In the current era of rapid technological advancements, education systems must adapt, particularly by integrating technology into classroom instruction (Ross, 2020; Haleem et al., 2022). However, the integration of technology in mathematics education remains limited and often lacks the necessary strategic focus (Cahyono & Ludwig, 2018; Viberg et al., 2023). When technology is aligned with students' daily activities and cultural contexts, it has the potential to greatly enhance their comprehension of mathematical concepts (Drijvers, 2015; Shonfeld et al., 2021). Although there is concern that excessive reliance on technology may lead to reduced student engagement and increased dependency (Demetriou, 2023), numerous studies have demonstrated the significant benefits of technology in accelerating classroom learning, particularly in mathematics (Attard & Holmes, 2022; Siegle & Hook, 2023; Tam et al., 2024). Therefore, it is crucial to adopt a technology-integrated approach that connects mathematics with students' lived experiences, sociocultural backgrounds, and cognitive development.

The Ethno-Realistic Mathematics Education (Ethno-RME) approach, which merges the principles of Ethnomathematics (Ethno) and Realistic Mathematics Education (RME), offers a framework for connecting mathematics with students' everyday experiences and cultural backgrounds. First introduced by Prahmana (2022), Ethno-RME emphasizes the process of mathematization while taking into account students' cognitive development. This approach integrates activities and contexts that reflect students' sociocultural environments, making mathematics more relevant and accessible (Prahmana et al., 2023). Furthermore, Ethno-RME is flexible and adaptable for technological integration (Alghiffari et al., 2024), such as through the use of applications like MathCityMap (Nurnaningsih et al., 2024), further enhancing its educational impact.

MathCityMap is a GPS-based mobile technology designed to enhance mathematics learning (Ludwig & Jesberg, 2015), built upon the concept of mathematical trails (Shoaf et al., 2004). Through MathCityMap, students embark on mathematical journeys by following a designated route and solving tasks related to real-world objects and situations (Cahyono & Ludwig, 2018). This aligns with the Ethno-RME principles by fostering mathematical discovery within authentic environments (Prahmana et al., 2023). It allows students to engage with mathematics in practical settings, promoting learning beyond traditional classroom confines (Richardson, 2004; Ludwig & Jesberg, 2015). Consequently, MathCityMap can be defined as an innovative educational tool that enhances mathematics learning through immersive, real-world exploration and problem-solving.

Indonesia's rich cultural heritage provides numerous opportunities to incorporate cultural contexts into mathematics education (Khasanah et al., 2023; Alghiffari et al., 2024; Pangestuti et al., 2024). For example, Magelang in Central Java, known as the "City of a Million Flowers" (Pamungkas et al., 2018), offers a culturally significant environment for teaching mathematics. Magelang Square, a well-known landmark with deep historical and sociocultural importance, serves as a familiar setting for local students. This site is particularly well-suited for exploring two-dimensional and three-dimensional geometric shapes within a real-world context.

In formal education, mathematics is frequently perceived as an abstract discipline, which detaches it from students' cultural backgrounds and lived experiences (Aikenhead, 2021; Schoenfeld, 2022). As a result, many students encounter difficulties in recognizing its practical relevance. To address this issue, it is essential to establish meaningful connections between mathematical concepts and students' sociocultural contexts (Prahmana & Istiandaru, 2021; Khasanah et al., 2023; Risdiyanti et al., 2024). The Ethno-RME approach, when enhanced by technology such as MathCityMap, facilitates this integration. This study aims to design a learning trajectory centered on two-dimensional geometric shapes, utilizing the Ethno-RME framework in conjunction with MathCityMap technology.

Magelang Square, located in Magelang, serves as the real-world context for this research. A design research methodology (Prahmana et al., 2017), specifically a validation study, was employed, incorporating methods such as photo and video documentation, interviews, and student worksheets. Data were analyzed using retrospective analysis techniques. The study culminated in a structured learning trajectory for teaching two-dimensional shapes, integrating Magelang Square with Ethno-RME (Prahmana, 2022) and MathCityMap (Ludwig & Jesberg, 2015). This trajectory comprises three activities designed within MathCityMap under the theme "Jejak Kota Sejuta Bunga" (Math Trace of the City of a Million Flowers). The implementation of this learning trajectory demonstrated that the integration of the cultural context of Magelang Square with Ethno-RME and MathCityMap enhances students' conceptual understanding of geometric shapes, particularly squares, triangles, and rectangles.

Previous studies have documented the use of ethnomathematics and MathCityMap in mathematics education. For example, Cahyono et al. (2023) explored the impact of ethnomathematics and MathCityMap on students' critical thinking, while Anggraeni et al. (2023) examined its effects on problem-solving skills. However, these studies focused solely on ethnomathematics, without integrating it into the Ethno-RME framework. This study addresses a gap in the literature by investigating the instructional design of mathematics learning that merges Ethno-RME with MathCityMap technology, emphasizing students' comprehension of two-dimensional geometric forms. This research offers novel insights into the integration of Ethno-RME and MathCityMap, providing valuable resources for mathematics educators, particularly in the Central Java region. Moreover, it serves as a foundational reference for academics seeking to conduct similar investigations in diverse educational settings.

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METHODS

The research methodology adopted in this study is rooted in validation studies, with a focus on developing and validating theoretical models derived from educational interventions (Plomp & Nieveen, 2007). The approach is structured into three distinct phases: the preliminary design, the design experiment, and the retrospective analysis, as outlined by Prahmana et al. (2017). Each phase is essential in systematically evaluating the effectiveness of the designed interventions and ensuring their practical relevance in an educational context. By utilizing this structured approach, the study aims to contribute to both theoretical advancement and practical application within the field of mathematics education.

The first phase, the Preliminary Design Stage, involves the development of a hypothetical learning trajectory (HLT). This trajectory serves as a blueprint for the learning process, detailing the steps that students are expected to follow. The HLT is designed with a focus on real-world problem-solving and is incorporated into the MathCityMap platform, which provides structured tasks and trails for students. These tasks are aligned with educational objectives and are aimed at facilitating students' understanding of mathematical concepts through contextual learning experiences. This phase is crucial as it lays the groundwork for the subsequent stages of the study.

In the Design Experiment phase, the hypothetical learning trajectory is implemented with a sample group of five students from schools located near Magelang Square. This stage is experimental in nature, as it tests the validity and effectiveness of the designed HLT in a real classroom setting. During this phase, researchers closely observe the interaction between students and the tasks presented in MathCityMap, collecting data on student performance, engagement, and learning outcomes. The observations and data gathered during this phase provide empirical evidence for refining the initial design and identifying areas for improvement.

Following the design experiment, the Retrospective Analysis phase is conducted to thoroughly analyze the results obtained from the experimental implementation. This phase involves a detailed examination of the data collected, focusing on whether the HLT achieved the desired educational outcomes. The retrospective analysis helps researchers to critically evaluate the effectiveness of the intervention, drawing connections between the theoretical framework and the practical results observed. It also serves as a basis for refining the HLT, ensuring its alignment with educational goals and its adaptability to different learning environments.

Finally, the findings from the retrospective analysis are presented descriptively, offering insights into the successes and challenges encountered during the study. The descriptive analysis provides a comprehensive understanding of how the educational intervention impacted student learning, highlighting both the strengths and limitations of the approach. This stage is essential for validating the research's theoretical contributions and offers practical recommendations for future implementations in mathematics education. Through this rigorous methodological framework, the study aims to bridge the gap between theory and practice, ultimately contributing to the advancement of effective educational interventions.

RESULTS AND DISCUSSION

The findings of this study demonstrate the implementation of a learning trajectory for two-dimensional shapes, utilizing Magelang Square as a real-world context through the Ethno-RME approach, supported by MathCityMap technology. In the preliminary design phase, researchers developed a mathematical trail within the MathCityMap platform, titled "Jejak Kota Sejuta Bunga" (Trace of a Million Flowers City), as depicted in Figure 1. The city of Magelang is widely recognized for its abundant floral displays, earning it the title "Kota Sejuta Bunga" (City of a Million Flowers) within the context of this mathematical exploration. This moniker is historically connected to the colonial period when Magelang, known for its numerous gardens, was referred to as 'Tuin Van Java,' a Dutch phrase that translates to "Garden of Java" (Pamungkas & Sultoni, 2020).

The name was attributed to Magelang due to the presence of beautiful flower gardens that enhanced the city's aesthetic appeal. The term 'Tuin van Java' thus inspired the contemporary designation of Magelang as the "City of a Million Flowers." Philosophically, flowers symbolize beauty, cleanliness, order, and comfort, aligning with the vision of Magelang as a city that embodies these ideals. Figure 1 illustrates the initial, map, and task views of the "Million Flowers City" math trail on

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MathCityMap. The trail is composed of three distinct activities: first, identifying mathematical elements within the wall ornaments of Magelang Square Park; second, locating mathematical features in the letter 'A' of the word 'MAGELANG'; and third, exploring geometric patterns on a spiral pot.

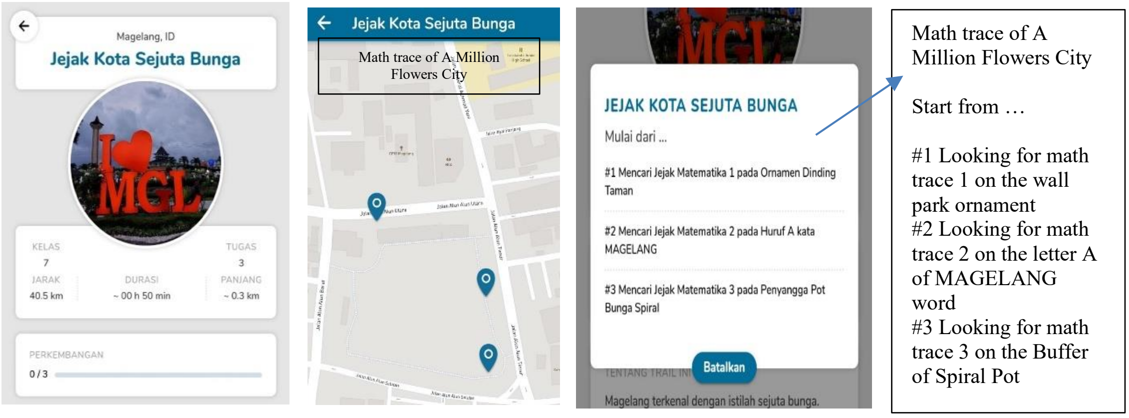

Figure 1. Math Trace of the Million Flowers City on MathCityMap

Activity 1: Identifying Mathematical Traces in Wall Ornaments

The initial activity involves the identification of "Math Trace 1," which is represented by the wall ornaments of Magelang Square Park. This task is designed to enhance students' comprehension of the geometric properties associated with squares, with a specific emphasis on the concept of rectangles. The ornamental design displayed on the park's wall is square in shape and features intricate floral carvings, as illustrated in Figure 2.

The square-shaped ornament depicted in Figure 2 serves as a valuable contextual reference for introducing fundamental mathematical concepts such as area, perimeter, angles, and the defining properties of squares. This activity is structured into four primary tasks, allowing students to engage with the geometric properties in a meaningful manner. The initial task requires students to accurately identify the shape of the ornament, thus grounding their exploration in a tangible example.

Following the identification task, students will be guided to measure the dimensions of the ornament. This measurement process facilitates a deeper understanding of how the properties of squares and rectangles are interrelated. Students will calculate the area and perimeter of the ornament, employing appropriate mathematical formulas. By engaging in these calculations, students will reinforce their understanding of the practical applications of geometry in real-world contexts.

Figure 2. The Wall Ornament of Magelang Square Park

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In addition to measurement, students will examine the angles formed by the corners of the square-shaped ornament. This investigation aims to solidify their grasp of the concept that all angles in a square are right angles, each measuring 90 degrees. By comparing the square to rectangles, students will explore the defining characteristics that distinguish these two geometric shapes, fostering critical thinking and comparative analysis.

To conclude the activity, students will engage in a reflective discussion regarding their findings. This discussion will encourage them to articulate their understanding of the concepts explored during the activity and to consider how these concepts can be applied in different mathematical contexts. Furthermore, students will be prompted to share their thoughts on the significance of recognizing geometric properties in everyday life.

In summary, this initial activity not only provides a foundation for understanding geometric properties but also promotes active learning through hands-on engagement with real-world objects. By integrating visual, tactile, and analytical approaches, students will develop a comprehensive understanding of squares and rectangles, thereby enhancing their overall mathematical literacy.

Next, they analyze its geometric properties by measuring the lengths of its sides, determining the magnitudes of its angles, and calculating both the area and perimeter. Prior to engaging with the core tasks, students are required to complete individual sub-tasks, which are outlined in Figure 3.

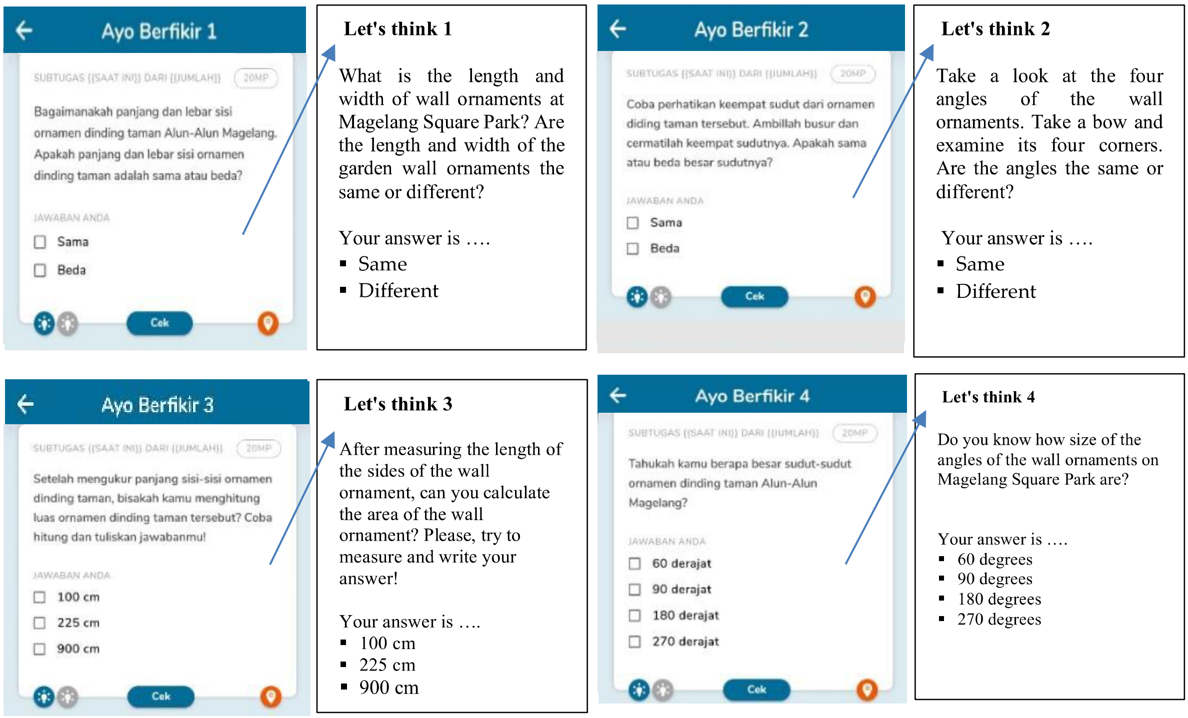

Figure 3. Sub-Tasks for the First Activity

Upon arriving at the designated location, indicated by the GPS within the MathCityMap platform, students begin by following the task instructions provided by the system. For the first sub-task, which involves determining the dimensions of the square, students utilize a tape measure to obtain the side lengths of the square. For the second sub-task, which examines the angles, students use a protractor to measure the angles of the ornament. In the third sub-task, students calculate the area of the ornament using the side measurements. The fourth sub-task requires students to calculate the perimeter, based on the side length measurements. The various measurement and calculation activities performed by the students during Activity 1 are illustrated in Figure 4.

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Figure 4. Students Measuring the Wall Ornaments

Within MathCityMap, students can directly input their responses to the assignment questions, as shown in Figure 5. Upon completing all sub-tasks, students conclude that a square has several key properties: all sides are equal in length, each angle measures 90 degrees, and the area is computed by squaring the side length. Through Activity 1, students gain a concrete understanding of the square by applying their measurements to the wall ornaments of Magelang Square Park.

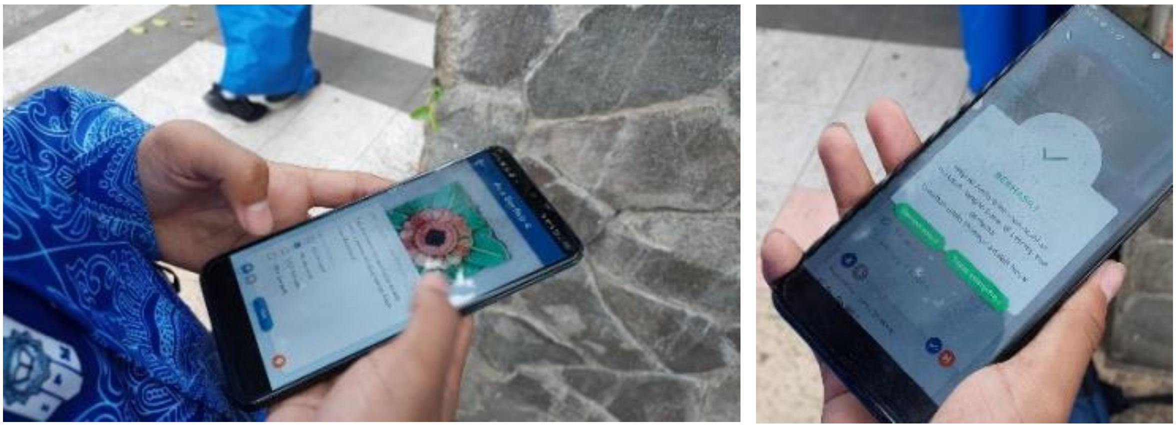

Figure 5. Students Inputting Responses for Activity 1

Figure 5 demonstrates the students' engagement in answering the tasks related to Activity 1. Through this process, students not only complete the tasks but also enhance their understanding of the square's mathematical properties. The process of mathematization is supported by tasks tailored to the students' cognitive abilities, enabling them to comprehend the essential characteristics of squares, such as equal side lengths and angles, and to accurately calculate the area and perimeter based on their real-world measurements.

Activity 2: Identifying Math Trace 2 in the Letter "A" of the Word MAGELANG

The second activity involves identifying Math Trace 2 by analyzing the letter "A" in the word 'MAGELANG'. This task is designed to enhance students' understanding of the geometric properties of triangles. The triangular shape, located at the center of the letter "A," serves as the focal point for understanding the characteristics of triangles, including their area and perimeter, as shown in Figure 6. The primary objective of Activity 2 is for students to recognize and analyze the triangular shape within the letter "A."

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Figure 6. Triangle in the Center of the Letter "A" in the Word MAGELANG

The letter "A" shown in Figure 6 is used as a practical context to explore various properties of triangles, such as their area, perimeter, angles, and key characteristics. The activity is structured into four main tasks: first, students identify the shape of the letter "A"; second, they examine its characteristics by measuring the lengths of the sides and the angles of the triangle; and third, they calculate both the area and perimeter of the triangle. Before engaging in the main task, students are required to individually complete a series of sub-tasks, as outlined in Figure 7.

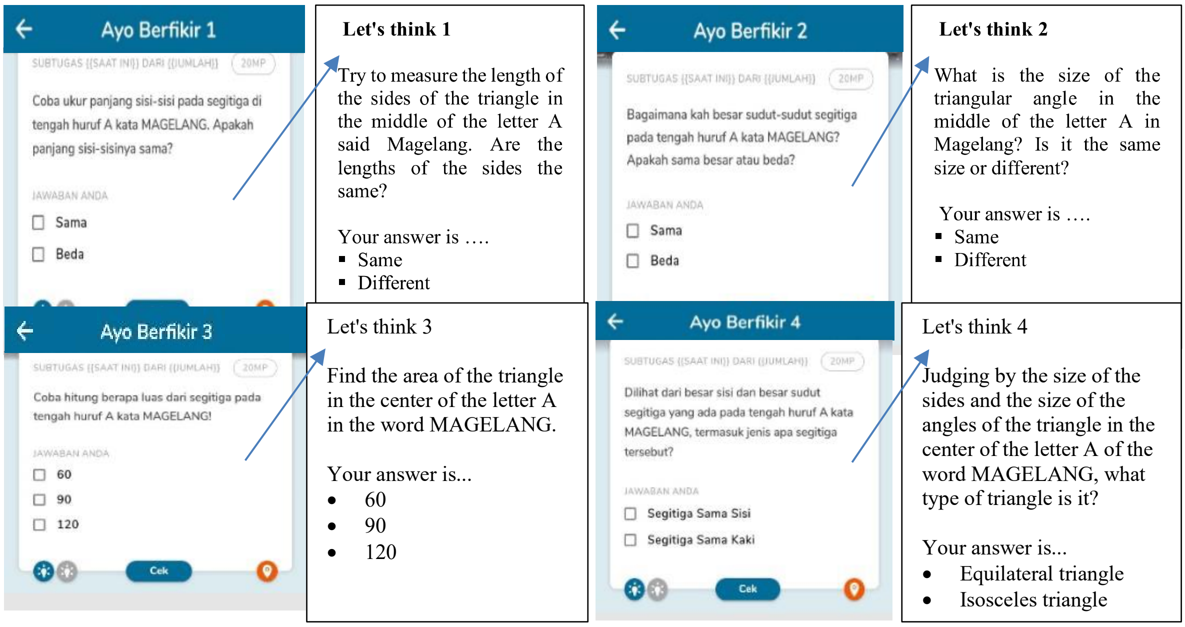

Figure 7. Sub-Tasks in Activity 2

The procedures employed in the first activity, including the use of GPS to locate the task site within MathCityMap, are repeated for Activity 2. Students then proceed with the measurement and calculation activities, as depicted in Figure 8.

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Figure 8. Students Measuring and Inputting Responses for Activity 2

Figure 8 demonstrates the students completing their responses to the tasks presented in Activity 2. After completing the sub-tasks, students conclude that a triangle possesses distinct properties: its side lengths may be equal or unequal, its angles may vary, and its area is determined by multiplying half the base length by the height of the triangle. Through Activity 2, students develop a concrete understanding of the triangle by applying their measurements and calculations to the triangular shape within the letter "A" of the word 'MAGELANG'. The hands-on experience gained from this activity allows students to grasp the fundamental geometric concepts of triangles, reinforcing their learning through real-world application within their local environment.

Activity 3: Identifying Math Trace 3 on the Buffer of the Spiral Pot

The third activity focuses on identifying Math Trace 3, located on the buffer of a spiral pot. This task is intended to introduce students to the concept of a rectangle, including its properties and area. The buffer of the spiral pot is composed of multiple stacked rectangles that form a spiral structure, as depicted in Figure 9.

Figure 9. Rectangular Shapes on the Buffer of the Spiral Pot in Magelang Square

The buffer of the Spiral Pot, located in Magelang Square, provides a real-world context for understanding rectangles and exploring their area, perimeter, angles, and distinguishing characteristics. This contextual approach is intended to engage students in discovering mathematical concepts.

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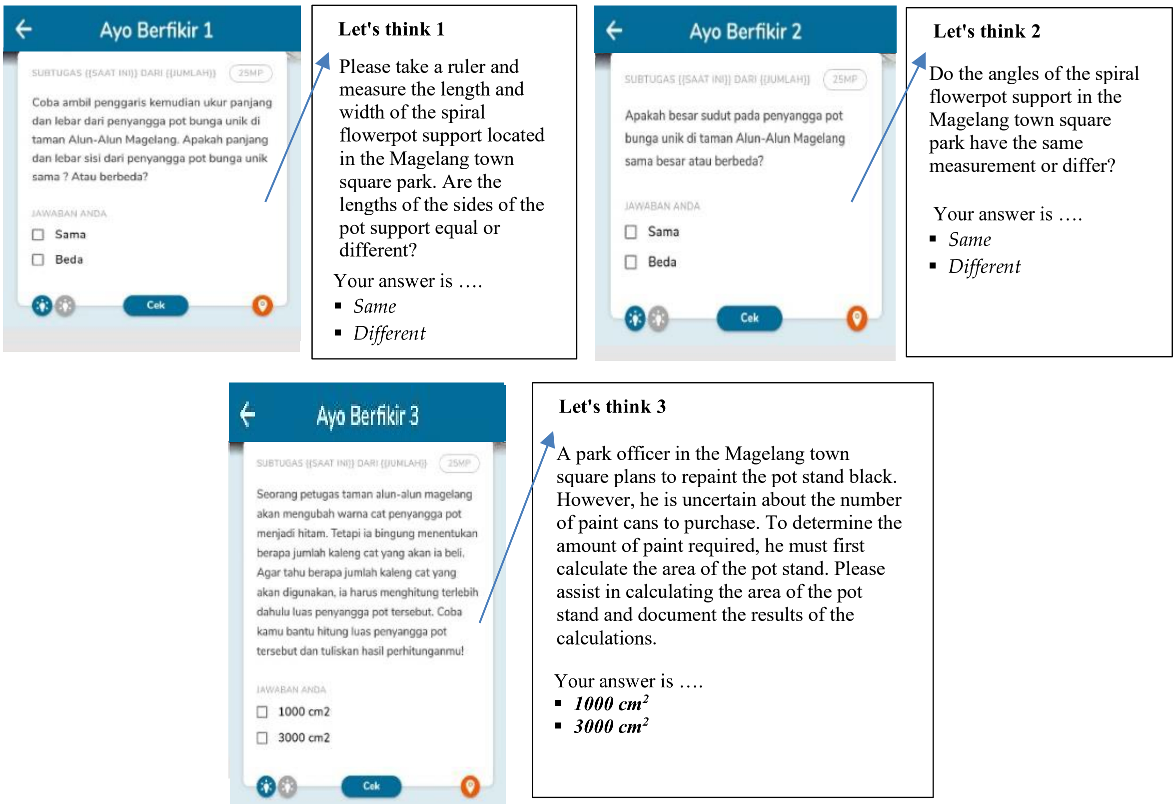

Figure 10. Sub-Tasks in Activity 3

In this activity, students are tasked with four main objectives: identifying the buffer of the Spiral Pot, analyzing its geometric characteristics by measuring the side lengths, determining the angle sizes, and calculating the area and perimeter of the rectangles. Prior to completing the primary task, students must work through a series of individual sub-tasks, as shown in Figure 10.

Following GPS-based instructions provided through the MathCityMap application, students locate the Spiral Pot. They then proceed to conduct measurements and complete the assignments. In sub-task 1, students measure the width and length of the rectangles on the spiral pot's buffer using a tape measure. Subsequently, they determine the angle of the rectangle by employing a bow. In sub-task 3, students calculate the area of the rectangle by applying the side measurements they obtained earlier. Figure 11 illustrates the students' engagement in measurement and calculation during Activity 3.

Figure 11. Students Measuring and Completing Activity 3 Tasks

In Figure 11, students can be seen completing the assigned tasks. Upon finalizing all sub-tasks, the students conclude that a rectangle has distinct properties, including unequal side lengths, equal

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angles measuring 90 degrees, and an area that can be calculated by multiplying the length and width. Activity 3 facilitates students' mathematical reasoning by aligning tasks with their cognitive levels, thereby fostering a deeper understanding of the rectangle and enabling them to compute its area.

The study's findings suggest that integrating the Ethno-RME approach with the MathCityMap application effectively supports students' mathematization processes. The combination of these methods not only engages students' interest in learning mathematics but also helps them recognize that mathematical concepts are present in their everyday surroundings. This is evidenced by the students' enthusiasm and successful task completion during the math trail activities. Additionally, Magelang Square serves as a rich context for students to observe and reflect on various culturally significant objects, such as the Pangeran Diponegoro monument located on the eastern side of the Square (Figure 12).

Pangeran Diponegoro, a key historical figure in Indonesia's fight against Dutch colonial rule in the 19th century, symbolizes resistance and patriotism. The monument embodies his legacy, which resonates deeply with students, fostering a sense of national pride and historical awareness (Sudardi & Istadiyantha, 2019). Pangeran Diponegoro's efforts during the conflict in Magelang are particularly noteworthy, as he led numerous battles against Dutch forces in the area, seizing fortifications and participating in critical engagements. By encountering this monument, students are reminded of the enduring spirit of nationalism, reinforcing their connection to Indonesia's cultural and historical heritage.

Figure 12. Students Observing the Pangeran Diponegoro Monument in Magelang Square

The learning design for two-dimensional shapes, implemented through the Ethno-Realistic Mathematics Education (Ethno-RME) approach and MathCityMap within the "Math Trace of a Million Flower City" framework, adheres to fundamental principles of Ethno-RME. This design facilitates a pedagogical progression from informal to formal mathematical learning. The principles of guided reinvention and mathematical progression emphasize that students cultivate mathematical understanding by transitioning from real-world problems to formal mathematical concepts (Treffers, 2012; Inci et al., 2023). Through the tasks offered via MathCityMap, students are empowered to construct models independently, progressing from concrete representations to formal mathematical ideas.

Research conducted by Nurnaningsih et al. (2024) supports these findings, indicating positive impacts such as enhanced conceptual understanding and improved mathematics performance among students. This improvement results from the integration of the Ethno-RME approach with digital technology, specifically MathCityMap, which effectively supports students' mathematical learning. Additionally, the Ethno-RME principle of self-developed models further elucidates this progression, illustrating how students transition from situational (real-world) contexts to referential, general, and ultimately formal levels of mathematical knowledge (Prahmana, 2022; Prahmana et al., 2023).

This learning design integrates measurement and problem-solving activities facilitated by tasks in MathCityMap, effectively guiding students' cognitive processes from practical experiences to formal

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mathematical ideas. Zulkardi (2002) notes that informal approaches can significantly enhance students' transition toward formal mathematical reasoning. The structure of this learning design aligns with existing research that demonstrates the efficacy of the Ethno-RME approach in improving students' comprehension of mathematical concepts (Nurnaningsih et al., 2024; Alghiffari et al., 2024; Pujiastuti et al., 2025). This progression from informal to formal understanding is critical for deepening students' mathematical knowledge.

Moreover, this approach integrates various contextual elements found within Magelang Square, including ornamental wall features, the letters spelling "Magelang," and the spiral pot. These cultural and contextual artifacts serve as foundational components for the learning activities, aligning with the Ethno-RME methodology, which prioritizes the initiation of learning through real-life experiences (phenomenological investigation) to engage students in contextualized mathematical learning. Conversely, Prahmana et al. (2023) articulate that beginning the learning process with everyday phenomena cultivates a stronger connection between students' lived experiences and formal mathematical concepts.

Furthermore, this approach aligns with D'Ambrosio's (2006) ethnomathematics framework, which emphasizes the significance of utilizing cultural and life-contextual mathematics to bridge students' understanding. By embedding ethnomathematical contexts within the curriculum, students can relate specific cultural experiences to mathematical ideas, thereby fostering a deeper comprehension of these concepts (Rosa & Orey, 2021; Risdiyanti et al., 2024; Pangestuti et al., 2024). The utilization of Magelang Square as a contextual framework enables students to develop mathematical ideas that are grounded in their cultural environment, thus supporting their cognitive development. Additionally, this approach enhances students' appreciation of cultural diversity, as evidenced by Peni's (2021) research, which illustrates how ethnomathematics can promote an understanding of diverse mathematical perspectives. Finally, this study provides valuable insights for educators and researchers aiming to develop innovative learning designs. By integrating mathematics education with cultural contexts, this research underscores the importance of linking students' learning experiences to their cultural backgrounds, thereby contributing to both educational practices and scientific research in the field.

CONCLUSION

This study successfully developed a learning trajectory for teaching two-dimensional geometric forms using the Ethno-Realistic Mathematics Education (Ethno-RME) approach, integrated with the MathCityMap application. The learning trajectory, presented as a Math Trace within the context of "A Million Flowers City," included three core tasks focusing on identifying mathematical traces in various objects around Magelang Square. Through the activities involving wall ornaments, the letter "A" in "MAGELANG," and a spiral pot, students were guided to discover and understand the properties of squares, triangles, and rectangles. The learning design emphasized the mathematization process, progressing from concrete real-world problems to formal mathematical concepts. The findings demonstrate the effectiveness of Ethno-RME in enhancing students' understanding of two-dimensional shapes by linking mathematics to real-life cultural contexts.

Despite the promising results, this study has several limitations. First, the research focused solely on two-dimensional geometric concepts within the specific cultural setting of Magelang Square. While the MathCityMap tasks were effective in facilitating the learning process, the study did not explore other mathematical concepts or cultural artifacts that could further enrich the Ethno-RME approach. Additionally, the study's sample size and context were limited to a specific location, which may affect the generalizability of the findings. Further research is needed to explore the applicability of the learning trajectory in different cultural and educational settings, as well as to investigate how it can be extended to other mathematical domains, such as three-dimensional shapes and algebraic concepts.

Future research should expand the learning trajectory to cover a broader range of mathematical topics and cultural artifacts, both within and beyond the Magelang Square context. By incorporating additional real-world objects and cultural elements, researchers can develop a more comprehensive Ethno-RME framework that connects mathematics to diverse cultural backgrounds. Furthermore, longitudinal studies could investigate the long-term impact of Ethno-RME on students' mathematical understanding and attitudes towards mathematics. Exploring how this approach influences other aspects

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of student learning, such as critical thinking and problem-solving skills, could also provide valuable insights for educators seeking to implement culturally relevant pedagogy in mathematics education.

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