Design of Quadrilateral Teaching Materials Assisted by GeoGebra in the Context of the Joglo Mosque UNESA 5 Campus

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Abstract

The integration of local culture and digital technology into mathematics learning has become an important strategy for creating meaningful learning experiences. However, learning materials about quadrilaterals are generally still abstract and rarely incorporate local cultural contexts supported by interactive technology. Therefore, this study aims to design learning materials for quadrilaterals by integrating the ethnomathematics context of the Joglo Al-Hasan Mosque at UNESA Campus 5, using the Realistic Mathematics Education (RME) approach, and GeoGebra as an interactive visualization tool. This study uses a Research and Development (R&D) approach that focuses on the design phase of the ADDIE model. The design process consists of needs analysis through a literature review, identification of quadrilateral concepts embedded in the mosque architecture, formulation of learning outcomes, preparation of learning activities, selection of learning methods and media, development of assessment instruments, and preparation of learning material designs. The resulting design integrates realistic learning scenarios, GeoGebra-assisted exploration activities, student worksheets, problem-solving tasks, and assessments aligned with the learning objectives. Learning activities are structured to facilitate students in building quadrilateral concepts through exploration, mathematical reasoning, discussion, and reflection based on meaningful real-life contexts. This study provides a theoretically grounded blueprint for developing culturally responsive and technology-enabled learning materials that support the implementation of contextual mathematics learning in the 21st century. Further research is recommended to continue the development, implementation, and evaluation stages to test the validity, practicality, and effectiveness of the proposed teaching materials.

Keywords: Design and Development Research, Ethnomathematics, GeoGebra, Joglo Al-Hasan Mosque, Quadrilaterals.

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INTRODUCTION

The integration of mathematics into social life is facilitated by the ethnomathematics approach, first proposed by d'Ambrosio. Ethnomathematics is viewed as the practice of mathematics within a cultural group, such as local communities, laborers, children of a certain age, professionals, and other groups (d'Ambrosio, 1985; Rosa et al., 2016; Rosa & Orey, 2020). This practice is realized through learning with the acculturation of mathematical concepts and unique learning strategies tailored to the unique characteristics of students and the local culture (Putra et al., 2020). Furthermore, ethnomathematics can enhance creativity, foster respect, solidarity, and cooperation among students (Melisa et al., 2019; Rosa et al., 2017). This perception suggests that contextual and meaningful mathematics learning can enhance students' various thinking skills (Musyarrofah & Guntur, 2026).

This is because students continuously construct knowledge from familiar and engaging situations through the context presented (Sarwoedi et al., 2018). Furthermore, students actively collaborate using their existing knowledge. This leads to the creation of new knowledge through reflective and active learning (Saputri et al., 2021). Integrating local cultural contexts into learning makes them more engaging and meaningful for students (Febriani et al., 2019). Thus, students can foster a sense of love and ownership of their culture while learning mathematics (Tri et al., 2020).

Every university in Indonesia generally has a mosque as a supporting facility for the religious activities of its academic community. Interestingly, these mosques have different architectural characteristics because they adopt elements of local culture, history, and institutional philosophy (Dwiandhini et al., 2023), thus forming a unique visual identity for each campus. One example of a campus mosque that represents local cultural identity is the Joglo Al-Hasan Mosque on Campus 5 of UNESA, located in Magetan. The joglo architecture applied to the mosque symbolizes the fusion of Islamic values and Javanese culture (Kholisa, 2021), thus having the potential to be a medium for cultural education (Setyaningrum & Untarti, 2024), character building, and the introduction of local wisdom for the academic community and the community.

Research on ethnomathematics in mosque buildings shows that mosque architecture is a cultural object rich in mathematical concepts and holds great potential as a contextual learning resource. Various studies have identified that the architectural elements, ornaments, and spatial layout of mosques contain concepts of geometry, transformation, measurement, and mathematical patterns that can be integrated into mathematics learning (Dwiandhini et al., 2023; Masamah, 2019; Meika et al., 2025; Muslim et al., 2024; Musyarrofah & Guntur, 2026; Norhikmah et al., 2024; Pramulia et al., 2025; Ridho'i, 2024; Soebagyo & Luthfiyyah, 2023; Waluya et al., 2024).

Research conducted at the As-Su'ada Campus Mosque, NU University, South Kalimantan, showed that the As-Su'ada Campus Mosque has many geometric shapes on the exterior and interior of the mosque. The results of the study recommend that learning that can be done include a case study of the mosque roof, a study tour to identify the geometric shapes of the mosque, and determining the building area (Muslim et al., 2024). Research conducted at the Al-Munawarah Grand Mosque in Banjarbaru, the results of the study showed that the mosque building contains various ethnomathematic concepts that can be used to introduce and understand geometric concepts through local culture. then developed into a mathematics test package for students (Norhikmah et al., 2024).

A similar study was also conducted at the Kauman Grand Mosque in Semarang, the results of the study indicate that the architecture of the Kauman Grand Mosque in Semarang has ethnomathematics related to mathematical concepts, including geometric concepts of spatial geometry such as cubes, cuboids, pentagonal prisms, rectangular pyramids, and cylinders. These mathematical concepts can be used as learning materials to introduce and understand the concepts of surface area and volume of spatial geometry through local culture (Meika et al., 2025). Research on the Architecture of the Grand Mosque of Nurul Kalam Pemalang. The results of the study indicate that there are 6 basic mathematical activities in the architecture of the Grand Mosque of Nurul Kalam Pemalang, which can be seen from the planning design concept that shows the spatial layout, symbols, motifs, and typical building forms of Pemalang (Waluya et al., 2024). In addition, research exploring ethnomathematics aspects at the Grand Mosque of Al-Barkah in Bekasi (Soebagyo & Luthfiyyah, 2023). The results of the study indicate that the Grand Mosque of Al-Barkah contains various geometric shapes and transformation elements, such as reflection, rotation, and translation, which have cultural and spiritual meaning (Soebagyo & Luthfiyyah, 2023).

Another study, ethnomathematics at the Sang Cipta Rasa Grand Mosque, integrated ethnomathematics, the CPS approach, and Lego media to develop students' mathematical content (Musyarrofah & Guntur, 2026). These findings reinforce the notion that mosques are a potential cultural object for developing contextual mathematics learning through an ethnomathematics approach. This demonstrates that mosque buildings represent not only simple geometric concepts but also advanced mathematical concepts with high cultural value (Musyarrofah & Guntur, 2026).

Research on the development of geometry teaching materials has largely integrated GeoGebra software to improve visualization skills (Simbolon, 2020; Sumarni & Prayitno, 2016) and conceptual understanding (Afhami, 2022), as well as applying ethnomathematics as an effort to link mathematics with local culture (Anam et al., 2024; Kariadinata et al., 2023; Rewatus et al., 2020). However, most studies still examine these two aspects separately and have not utilized mosque architecture as a learning context. In addition, the integration of Realistic Mathematics Education (RME), ethnomathematics, and GeoGebra in the design of geometry teaching materials is still relatively limited. Therefore, this study proposes a design for teaching materials on quadrilaterals that integrates the context of the Joglo Al-Hasan Mosque, Campus UNESA 5, with the RME approach assisted by GeoGebra. The novelty of this research lies in the use of mosque architecture as an ethnomathematics context combined with digital technology to produce a more contextual, interactive, and meaningful learning design.

METHOD

This study uses Research and Development (R&D) approach with a focus on the design stage referring to the ADDIE model. This approach aims to produce a systematic design of mathematics teaching materials based on needs analysis and theoretical foundations before entering the product development stage. In this study, the design stage is focused on the preparation of teaching materials on quadrilaterals that integrate the cultural context through the Joglo Al-Hasan Mosque, UNESA 5 Campus by utilizing the GeoGebra software application as a visualization medium for geometric concepts. The R&D approach was chosen because it allows the development of learning tools oriented towards solving educational problems through a systematic and theory-based design process (Sumarni et al., 2022; Sunzuma & Umbara, 2025).

The design phase begins with a needs analysis through a literature review of the mathematics curriculum, the characteristics of quadrilateral material, ethnomathematics-based geometry learning, the use of GeoGebra in mathematics learning, and a study of the architecture of the Joglo Al-Hasan Mosque as a cultural context. The needs analysis aims to identify mathematical concepts contained in the mosque's architectural elements, student characteristics, and contextual learning needs to provide a strong foundation for developing teaching materials. Needs analysis is a crucial stage in the development of learning tools because it determines the suitability between learning objectives, student characteristics, and the learning context (Alyusfitri et al., 2024).

Based on the results of the needs analysis, a teaching material design was prepared that includes learning outcomes, learning objectives, learning flow, learning syntax, learning methods, learning media, and assessments. The learning outcomes are designed so that students are able to identify the concepts of quadrilaterals in the architecture of the Joglo Al-Hasan Mosque, analyze the properties of these plane figures, and visualize them using GeoGebra. The learning flow is arranged in stages starting from the exploration of cultural objects, identification of mathematical concepts, construction of concepts using GeoGebra, to solving contextual problems. The preparation of this learning flow refers to the principle of meaningful learning that connects real experiences with mathematical concepts so as to improve students' conceptual understanding (Rosa & Orey, 2020).

The learning method was designed using the Realistic Mathematics Education (RME) approach combined with an ethnomathematics approach and exploratory activities assisted by GeoGebra. The RME approach was chosen because it is able to connect mathematical concepts with real-life contexts so that learning becomes more meaningful (Fauzan et al., 2024). Meanwhile, the ethnomathematics approach allows students to understand mathematical concepts through local cultural objects, thereby increasing appreciation for culture as well as mathematical abilities (Musyarrofah & Guntur, 2026). GeoGebra is used as an interactive medium to dynamically visualize geometric shapes, explore geometric properties, and support students' mathematical investigative activities (Johar et al., 2025; Noverianto et al., 2024).

The main output of the design phase is a blueprint for teaching materials containing the material structure, sequence of learning activities, GeoGebra usage scenarios, student activity sheets, and assessment designs aligned with learning outcomes. The blueprint provides a systematic specification for subsequent product development by ensuring constructive alignment among intended learning outcomes, learning activities, instructional media, and assessment (Pereira et al., 2024).

All teaching materials are designed based on theoretical foundations that include constructivism theory, RME, ethnomathematics, geometric representation theory, and the use of Software GeoGebra in mathematics learning. The integration of these theories is used as a basis for determining material content, learning activities, media selection, and assessment forms, resulting in a teaching material design that integrates pedagogical, mathematical, cultural, and technological aspects in an integrated manner.

RESULT AND DISCUSSION

Result

This research was conducted using the ADDIE model, but the results presented in this article are limited to the design stage. This stage is a continuation of the previously conducted needs analysis, focusing on designing teaching materials that are appropriate to student characteristics and learning objectives.

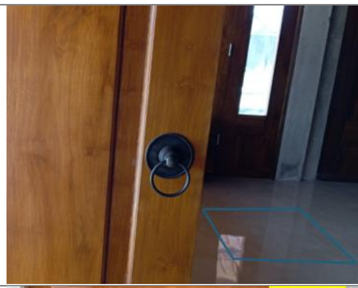
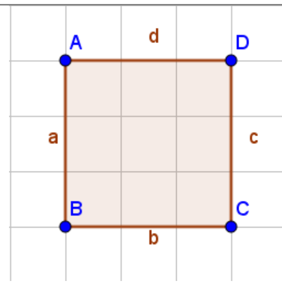
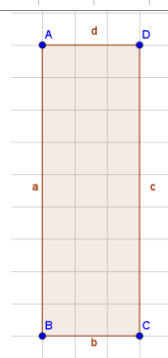
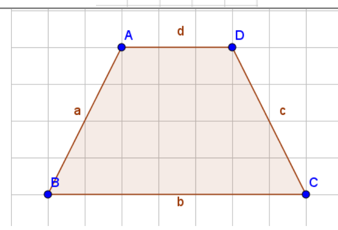
1. Designing the Structure of Teaching Materials

The teaching materials are designed in the form of systematic learning modules, including: introduction, concept maps, context-based learning activities, exploration using GeoGebra, practice questions, and reflection. This structure is designed to support student-centered learning and facilitate a gradual understanding of the concept of quadrilaterals.

2. Integration of the Joglo Mosque Context on UNESA 5 Campus

During the design phase, the Joglo Mosque context on UNESA 5 Campus was integrated as a contextual learning resource. Building elements such as floors, windows, and roof were identified as representations of quadrilaterals, such as squares, rectangles, and trapezoid. Based on observations made during the research, the concept of a quadrilateral found in the Al-Hasan Joglo Mosque on the UNESA 5 Campus was obtained, as shown in Table 1.

Table 1. Mathematical Concept of Plane Shapes in the Al-Hasan Joglo Mosque on the UNESA 5 Campus

No.	Figure	GeoGebra-Assisted Visualization	Explanation
1.			The results of observations on the floor in the main area of the mosque are square, in the form of large ceramic tiles measuring 60 × 60 cm to give a spacious and clean impression.
2.			The results of observations on the doors and windows of the mosque are rectangular, made of teak wood and have carved ornaments with floral or plant motifs on both the doors and windows.
3.			The results of observations on the roof of the mosque are in the form of tiered pyramids (*joglo tumpang sari*). Traditional Joglo architecture is characterized by an overlapping tajug roof structure with each layer resembling a trapezium-shaped plane.

This context was designed in the form of contextual problems that guided students to observe, identify, and analyze the properties of quadrilaterals based on real objects in their environment.

3. GeoGebra-Assisted Learning Activity Design

GeoGebra is used as a medium to dynamically visualize the concept of quadrilaterals. In the design phase, the activities developed include: constructing various types of quadrilaterals, the properties of quadrilaterals (side lengths, angles, diagonals), manipulating points to observe changes in shape, interactively testing the properties of quadrilaterals.

a. Constructing various types of quadrilaterals
In this activity, students construct various types of quadrilaterals, such as squares, rectangles, and trapezoids, using the GeoGebra application. The activity begins by determining the coordinates of points according to the instructions, then connecting the points using the Polygon feature to form the desired quadrilateral.

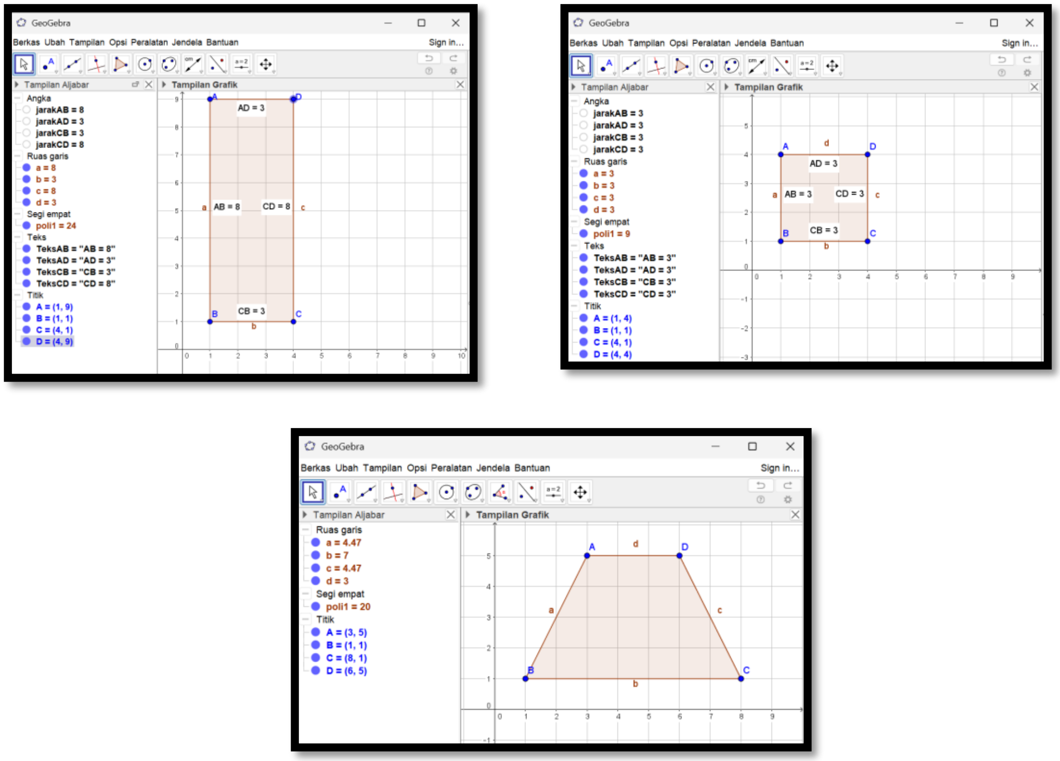


Figure 1. Squares, Rectangles, and Trapezoids, using the GeoGebra Software

b. The properties of quadrilaterals (side lengths, angles, diagonals)
Once the shape is formed, students explore the characteristics of each shape by utilizing GeoGebra's measurement features to observe side lengths, angle measures, parallel side relationships, and symmetry properties.

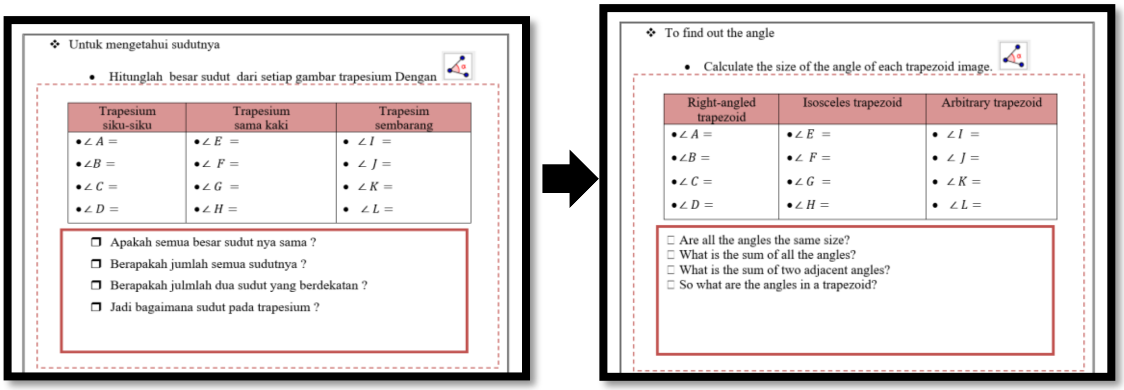


Figure 2. Explore the characteristics of trapezoid by utilizing GeoGebra's measurement features

c. Manipulating points to observe changes in shape
Students compare the characteristics of squares, rectangles, and trapezoids to identify their similarities and differences based on the results of their exploration. Through these construction and investigation activities, students are expected to be able to build a conceptual understanding of the classification and properties of quadrilaterals independently through the process of observation, measurement, and mathematical reasoning.

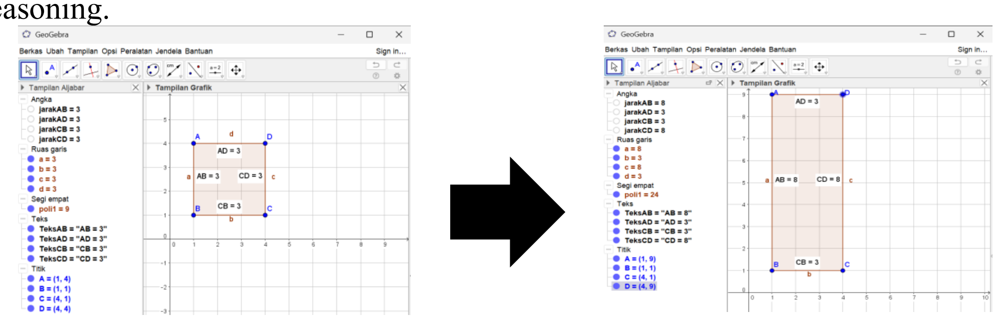


Figure 3. Manipulating points to observe changes in shape square to rectangles

This activity is in line with the principles of RME, which emphasizes concept formation through exploration, modeling, and discussion, so that learning becomes more meaningful and contextual.

d. Interactively testing the properties of quadrilaterals

In this activity, participants are taught to interactively test the properties of various quadrilaterals using the GeoGebra application. After successfully constructing shapes such as squares, rectangles, and trapezoids, students utilize the drag (shifting the vertices), distance or length, angle, and parallel lines features to observe changes and maintain the properties of each shape. Through this activity, students investigate the relationships

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between sides, angles, diagonals, lines of symmetry, and rotational symmetry, and compare the characteristics of each type of quadrilateral. When the vertices are shifted, students observe that although the shape and size of the shape change, its essential properties remain true within the resolution of the shape.

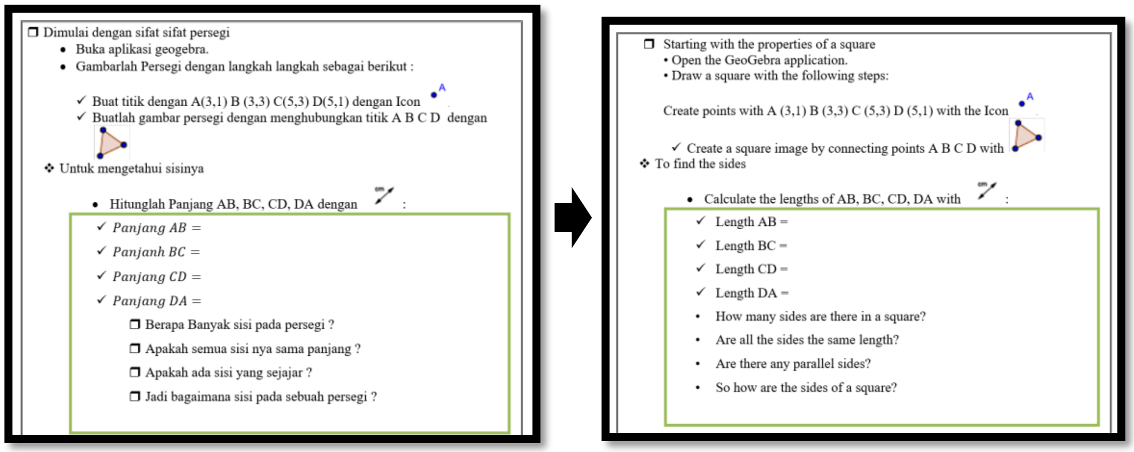

Figure 4. Interactively Testing the Properties of Square

The observations are then discussed to explain the mathematical reasoning underlying each discovered property. This dynamic testing activity helps participants learn concept verification through hands-on experience, develop critical thinking and geometric reasoning skills, and strengthen conceptual understanding of the classification and properties of quadrilaterals. Thus, GeoGebra not only functions as a visualization medium, but also as an investigative tool that enables students to build mathematical concepts through a process of exploration, testing, and reflection in accordance with the principles of Realistic Mathematics Education (RME). These activities are designed to improve students' visualization skills and conceptual understanding.

4. Student Worksheet Design

The Student Worksheet Design is designed based on a contextual approach with the following stages:

a. Problem orientation based on the context of the Joglo Mosque
The teacher displays a picture of the roof of the Joglo Al-Hasan Mosque, Campus 5, UNESA, as shown in Figure 1. The peak of the roof, outlined in red, shows a plane figure with two parallel sides. The teacher then invites students to observe this shape and relate it to everyday experiences of seeing traditional buildings in the surrounding area.

Figure 5. the Al-Hasan Joglo Mosque on the UNESA 5 Campus

The teacher asks the following probing questions:

"*Look at the roof of the Joglo Al-Hasan Mosque, outlined in red. What do you think is the plane figure formed? Why do you classify this shape as that figure?*"

After students identify that the shape resembles a trapezoid, the teacher continues with a more challenging question:

"*If this part of the roof is to be renovated with new roof tiles, how would you determine the surface area of the roof defined by the red line? What information would you need to know? Are all sides the same length? What is the relationship between parallel sides?*"

The teacher then asks students to measure the lengths of the sides of the shape using GeoGebra based on the provided image. Students then discuss the properties of the shape, determine the type of trapezoid formed, and develop strategies for calculating its perimeter and area. Through this activity, students are expected to develop their own concepts about the properties of trapezoids, the relationships between the shape's elements, and the formulas for area and perimeter based on the real-world architectural context of the Joglo Al-Hasan Mosque.

b. Exploration Using GeoGebra Software
After students gain an initial understanding of the problem context and identify rectangular shapes in the observed objects, the learning activity continues with exploration using GeoGebra software. The use of GeoGebra aims to help students visualize geometric shapes dynamically so they can observe the relationships between geometric elements more accurately. The following is one exploration activity using GeoGebra for the topic of properties of rectangles.

Students begin the exploration activity by opening the GeoGebra application and constructing a rectangle using four predetermined coordinate points: $A(2,1)$, $B(8,1)$, $C(8,4)$, and $D(2,4)$. The points are connected sequentially using the Polygon tool to form rectangle $ABCD$. This activity allows students to interact directly with the geometric object and observe its properties in a dynamic environment.

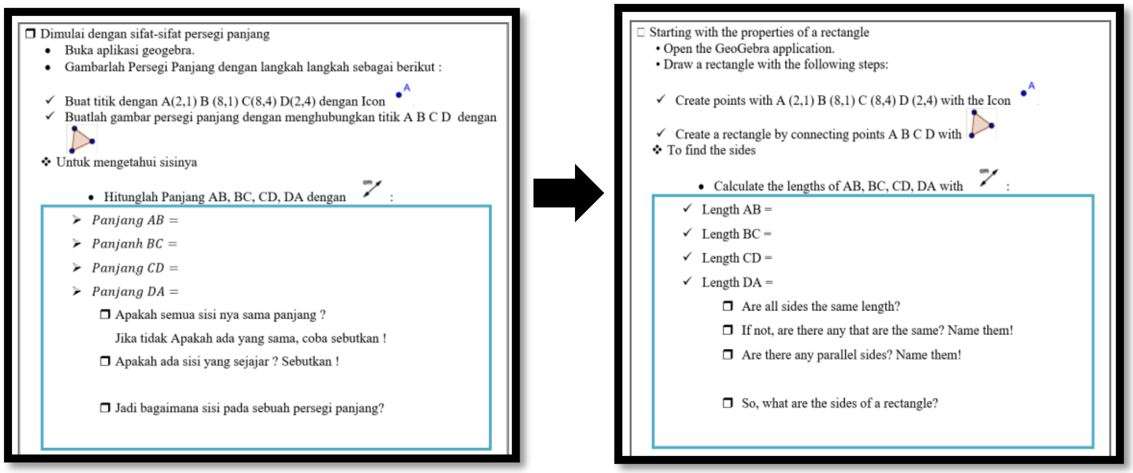

Figure 6. Exploration Using GeoGebra Software for the Topic of Properties of Rectangles

After constructing the rectangle, students use the Distance or Length tool to measure the lengths of sides AB, BC, CD, and DA. They record the measurements and compare the lengths of opposite and adjacent sides. Through this investigation, students discover that opposite sides have equal lengths, whereas adjacent sides have different lengths. Next, students examine the orientation of each side to identify pairs of parallel sides, concluding that $AB \parallel CD$and $BC \parallel AD$.

To strengthen conceptual understanding, students are guided to answer reflective questions regarding whether all sides have the same length, which sides are equal in length, and which sides are parallel. Based on their observations and discussions, they formulate the properties of a rectangle independently rather than receiving them directly from the teacher. This exploratory process encourages students to construct mathematical concepts through observation, measurement, comparison, and reasoning.

c. Discussion and Drawing Conclusions

After completing the exploration using GeoGebra, students work collaboratively in small groups to discuss the results of their observations and measurements. Each group compares the lengths of the sides, examines the angle measures, and analyzes the symmetry properties of the constructed rectangle.

During the discussion, students are encouraged to justify their findings using the measurement results obtained from GeoGebra and to explain the mathematical relationships they have discovered. The teacher facilitates the discussion by asking guiding questions such as:

"Which sides have equal lengths?"
"Which pairs of sides are parallel?"

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"What are the measures of the interior angles?"
"How many lines of symmetry does the rectangle have?" and
"How many times can the rectangle be rotated onto itself before returning to its original position?"
These questions stimulate students to communicate their reasoning, compare different ideas, and refine their understanding through peer interaction.

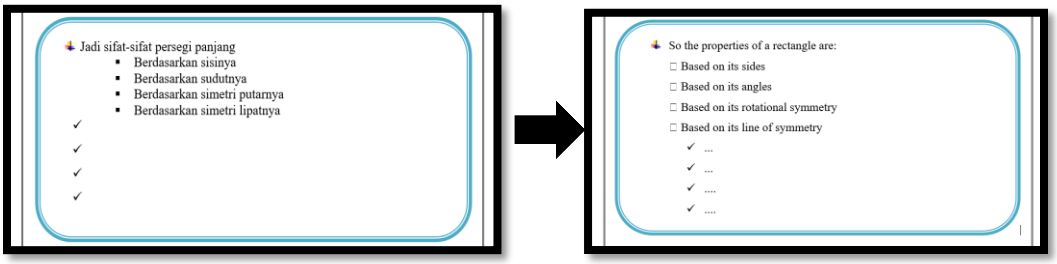

Figure 7. Student Worksheet for Drawing Conclusion

Based on the exploration and group discussion, students formulate the properties of a rectangle as follows:

1) Based on its sides: Opposite sides are equal in length and parallel, while adjacent sides are generally different in length.
2) Based on its angles: All four interior angles are right angles, each measuring 90°.
3) Based on rotational symmetry: A rectangle has rotational symmetry of order 2, meaning it coincides with itself after a rotation of 180°.
4) Based on reflection symmetry: A rectangle has two lines of symmetry, namely the horizontal and vertical axes passing through its center.

d. Problem-Solving-Based Practice Questions

To reinforce students' conceptual understanding of quadrilaterals, particularly trapezoids, students are provided with contextual problem-solving activities based on the architectural design of Joglo Al-Hasan Mosque, UNESA Campus 5 Magetan. The upper section of the mosque roof, highlighted in the image, forms an isosceles trapezoid, providing an authentic context for applying geometric concepts learned during the exploration phase.

Students are asked to observe the roof structure carefully and identify the geometric characteristics of the highlighted shape. They then solve a series of problems that require them to determine the type of quadrilateral, identify its properties, calculate its perimeter and area using the given dimensions, and explain the mathematical reasoning behind their solutions. Rather than directly applying memorized formulas, students are encouraged to

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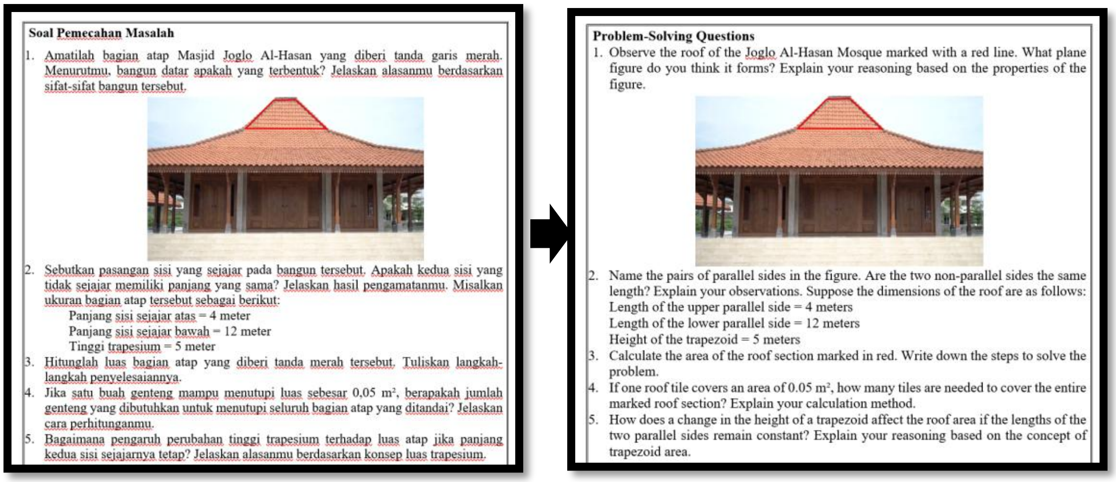
analyze the relationships among the parallel sides, non-parallel sides, and height of the trapezoid before developing appropriate solution strategies.


Soal Pemecahan Masalah

1. Amatilah bagian atap Masjid Joglo Al-Hasan yang diberi tanda garis merah. Menurutmu, bangun datar apakah yang terbentuk? Jelaskan alasanmu berdasarkan sifat-sifat bangun tersebut.
2. Sebutkan pasangan sisi yang sejajar pada bangun tersebut. Apakah kedua sisi yang tidak sejajar memiliki panjang yang sama? Jelaskan hasil pengamatanmu. Misalkan ukuran bagian atap tersebut sebagai berikut:
   Panjang sisi sejajar atas = 4 meter
   Panjang sisi sejajar bawah = 12 meter
   Tinggi trapesium = 5 meter
3. Hitunglah luas bagian atap yang diberi tanda merah tersebut. Tuliskan langkah-langkah penyelesaiannya.
4. Jika satu buah genteng mampu menutupi luas sebesar 0,05 m^2, berapakah jumlah genteng yang dibutuhkan untuk menutupi seluruh bagian atap yang ditandai? Jelaskan cara perhitunganmu.
5. Bagaimana pengaruh perubahan tinggi trapesium terhadap luas atap jika panjang kedua sisi sejajarnya tetap? Jelaskan alasanmu berdasarkan konsep luas trapesium.

Problem-Solving Questions

1. Observe the roof of the Joglo Al-Hasan Mosque marked with a red line. What plane figure do you think it forms? Explain your reasoning based on the properties of the figure.
2. Name the pairs of parallel sides in the figure. Are the two non-parallel sides the same length? Explain your observations. Suppose the dimensions of the roof are as follows:
   Length of the upper parallel side = 4 meters
   Length of the lower parallel side = 12 meters
   Height of the trapezoid = 5 meters
3. Calculate the area of the roof section marked in red. Write down the steps to solve the problem.
4. If one roof tile covers an area of 0.05 m^2, how many tiles are needed to cover the entire marked roof section? Explain your calculation method.
5. How does a change in the height of a trapezoid affect the roof area if the lengths of the two parallel sides remain constant? Explain your reasoning based on the concept of trapezoid area.

Figure 8. Problem-Solving-Based Practice Questions

The teacher facilitates students in connecting the architectural features of the mosque with mathematical concepts through guiding questions such as:

a. What type of quadrilateral is represented by the highlighted roof section? Explain your reasoning.
b. Which sides are parallel and which sides are equal in length?
c. If the upper base is 4 m, the lower base is 12 m, and the height is 5 m, determine the area of the roof section.
d. Estimate the amount of roof tiles required if one roof tile covers 0.05 m^2.
e. How would the area change if the height of the roof were increased while the lengths of the parallel sides remained constant?

These contextual questions encourage students to integrate mathematical concepts with real-life situations while developing problem-solving, reasoning, and mathematical communication skills. Through discussion and justification of their solutions, students are expected to recognize that mathematics can be used as an effective tool for solving practical problems encountered in architectural design and construction.

Discussion

The design phase demonstrated that the developed teaching materials integrated three main aspects: local context, technology, and Realistic Mathematics Education (RME) approach. The integration of the Joglo Mosque context provided a more meaningful learning experience because students could relate mathematical concepts to the real world. The use of GeoGebra in the learning design supported the visualization of abstract concepts in a more concrete and interactive way (Öçal, 2017). This aligns with the demands of 21st-century learning, which emphasizes the use of digital technology (Yildiz, 2016).

Exploration Using GeoGebra Software The use of GeoGebra provides dynamic visualization that enables students to manipulate geometric objects while preserving their properties (Nuraeni & Sukmaningthias, 2021). Consequently, students gain a deeper understanding of the relationships among the sides of a rectangle and develop stronger conceptual knowledge through active exploration. This activity is consistent with the principles of RME, where learners reinvent mathematical concepts through guided exploration of meaningful tasks (Y. M. Sari et al., 2024)supported by interactive digital technology (Anwar et al., 2024).

Through group discussion, students gradually recognize that a rectangle possesses several defining properties. They conclude that opposite sides are equal in length and parallel, all interior angles are right angles (90°), the rectangle has two lines of symmetry, and it has rotational symmetry of order two (180°). Rather than memorizing these properties, students construct their understanding through observation, measurement, discussion, and mathematical reasoning supported by GeoGebra (Nuraeni & Sukmaningthias, 2021). This process reflects the principles of RME, where mathematical concepts emerge from meaningful activities and social interaction (Dewantara et al., 2023).

Through drawing conclusions activities, students independently construct the concept of a rectangle by connecting measurement results, geometric visualization, and mathematical reasoning. The use of GeoGebra enables students to verify geometric properties dynamically, while the discussion process strengthens conceptual understanding (Mutia, 2017) and mathematical communication (Kania, 2018). Consequently, the learning process shifts from teacher-centered explanation to student-centered knowledge construction, which is consistent with the principles of RME (Tanujaya et al., 2017) and supports the development of students' conceptual understanding (A. Sari & Yuniati, 2018), creative thinking (Chahyanti, 2022) and problem-solving skills (Ginta Octizasari, 2018).The use of the mosque's roof as a learning context also introduces students to the cultural values embedded in local architecture (Musyarrofah & Guntur, 2026; Waluya et al., 2024), thereby integrating ethnomathematics into geometry learning (Masamah, 2019). This contextual approach is consistent with the principles of RME, where meaningful real-world situations become the starting point for students to reinvent mathematical concepts through exploration, modeling, and reflection (Tanujaya et al., 2017).

CONCLUSIONS

This study resulted in a design of learning materials for quadrilaterals that integrate the local context of the Joglo Al-Hasan Mosque at UNESA Campus 5, the Realistic Mathematics Education (RME) approach, and GeoGebra software as an interactive learning medium. The designed learning activities encourage students to build geometric concepts through contextual exploration, dynamic visualization, discussion, and mathematical reasoning, rather than through memorization.

The integration of ethnomathematics and digital technology creates a meaningful learning environment by connecting abstract mathematical concepts with local cultural heritage and supporting the development of conceptual understanding, mathematical communication, creative thinking, and problem-solving skills. Therefore, the resulting learning design provides a systematic framework based on constructivist theory for developing contextual geometry learning materials that meet the demands of 21st-century mathematics learning.

The proposed learning material design should proceed to the development, implementation, and evaluation stages of the ADDIE model to test its validity, practicality, and effectiveness in a classroom learning environment. Further studies are also recommended to expand the integration of local cultural contexts into other mathematics topics and optimize the use of GeoGebra software and similar dynamic mathematics software to support interactive mathematics learning. Furthermore, empirical studies involving teachers and students are needed to evaluate the impact of the learning material design on students' conceptual understanding, mathematical reasoning, and other higher-order thinking skills.

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