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RESIDENTIAL FLOOR TILING AS A MATHEMATICAL MODELING CONTEXT FOR GEOMETRY LEARNING IN JUNIOR HIGH SCHOOL

Akbar Nasrum*[1], Marniati[2]
[1,3] Universitas Sembilanbelas November Kolaka

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ABSTRACT

Mathematical modeling is a learning approach that emphasizes the connection between mathematical concepts and real-life situations. However, geometry instruction in junior high schools is still frequently presented in an abstract manner and lacks meaningful real-world contexts. This study aims to examine residential floor tiling as a mathematical modeling context for geometry learning at the junior high school level. The research was conducted using a subsidized house type 36 located in the Citra Latambaga Housing Complex, Latambaga District, Kolaka Regency, focusing on floor tiling activities involving various tile sizes and materials. A qualitative research design with a mathematical modeling approach was employed, encompassing problem identification, mathematical model formulation, model solution, and interpretation of results. The findings indicate that residential floor tiling involves multiple geometry concepts aligned with the junior high school curriculum, including area measurement, ratios, unit conversion, estimation, and mathematical decision-making. Variations in tile sizes and materials generate multiple mathematical solutions, encouraging students to engage in critical thinking, compare alternative strategies, and interpret mathematical results within a real-life context. These results demonstrate that floor tiling provides meaningful learning experiences and supports the development of students' mathematical modeling competencies. This study contributes theoretically to the body of research on mathematical modeling by introducing a familiar real-world context and offers practical implications for teachers in designing contextual and applicable geometry instruction at the junior high school level.

Corresponding Author:

Akbar Nasrum,
Departement of Mathematics Education,
Universitas Sembilanbelas November Kolaka, Indonesia
Email: akbar.nasrum@gmail.com

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1. INTRODUCTION

Mathematics is a fundamental discipline that plays a crucial role in developing students' logical, analytical, and problem-solving abilities. At the junior high school level, geometry is one of the core topics that requires students not only to understand formal concepts but also to apply them in real-life situations. However, many students experience difficulties in connecting geometric concepts with real-world contexts, resulting in less meaningful learning experiences and decreased learning motivation. This condition indicates the need for more contextual and authentic learning approaches so that students do not merely memorize procedures but also understand how mathematics is used in everyday life.

Mathematical modeling is a learning approach that emphasizes the relationship between mathematical concepts and real-world situations through the process of mathematizing, simplifying real-life contexts into mathematical models, analyzing these models, and interpreting the results back into the original situation (Blum & Leiss, 2007; Stillman et al., 2016). Mathematical modeling not only integrates higher-order thinking skills but also enriches students' learning experiences by engaging them in solving authentic problems. International studies have shown that cognitively demanding and authentic modeling tasks can enhance students' modeling competencies and strengthen the connection between school mathematics and the real world (Blum et al., 2017; Kaiser & Sriraman, 2020).

Recent research further indicates that the use of relevant and meaningful real-world contexts improves students' ability to model real-life situations using appropriate mathematical concepts. Well-designed modeling tasks encourage students to engage actively in interpreting and simplifying complex problems, as well as in developing mathematical argumentation skills (Borromeo Ferri, 2018; Maaß et al., 2019). Other studies emphasize that mathematical modeling activities enable students to integrate multiple geometric and arithmetic representations when dealing with real-world situations that require analytical calculations and rational reasoning (Lesh & Zawojewski, 2019; English, 2021).

In the context of geometry learning at the junior high school level, mathematics education research has demonstrated that using contexts closely related to students' experiences—such as household activities, daily lifestyles, or spatial design—helps students develop deeper conceptual understanding and better problem-solving skills compared to traditional instructional approaches (van den Heuvel-Panhuizen & Drijvers, 2020). Empirical findings also show that contextual learning approaches linking area concepts and two-dimensional shapes to everyday realities significantly improve students' understanding of geometry (Widjaja et al., 2021).

Numerous empirical studies have shown that approaches such as Realistic Mathematics Education (RME), which position real-world situations as the starting point of learning, are highly effective in improving students' mathematical competencies, including modeling skills and geometric understanding (Gravemeijer et al., 2017; Prahmana & D'Ambrosio, 2020). Similar contextual learning implementations using authentic problems have been found to produce higher learning achievement and mathematical thinking skills compared to conventional approaches (Suryadi et al., 2019).

Nevertheless, a research gap remains, particularly in studies that explicitly employ residential floor tiling as a mathematical modeling context for geometry learning at the junior high school level. Although several studies have explored mathematical modeling in various authentic contexts—such as environmental issues, technology, or other real-life situations—the use of spatial design or housing-related construction activities involving a combination of area concepts, decision-making, and cost estimation has not been extensively investigated (Patahuddin et al., 2021; Santos-Trigo & Moreno-Armella, 2022).

As an authentic context closely related to students' daily lives, residential floor tiling encompasses various mathematical aspects, including calculating floor area, converting tile measurement units, estimating the number of tiles based on room dimensions, and considering costs based on tile size and type. This context has strong potential as an authentic mathematical modeling task that requires students to translate real-world situations into formal mathematical representations, as well as to evaluate and interpret solutions reflectively.

Therefore, this study is designed to examine residential floor tiling as a mathematical modeling context for geometry learning at the junior high school level. The main objectives of this study are to (1) identify geometric concepts embedded in the floor tiling context, (2) analyze the stages of the mathematical modeling process that can be developed through this context, and (3) formulate recommendations for designing authentic geometry learning activities based on mathematical modeling.

The position of this study lies within the field of contextual mathematics education and mathematical modeling, aiming to bridge the gap between formal geometric concepts and students' real-world experiences. By positioning residential floor tiling as a complex yet familiar authentic problem for junior high school students, this study is expected to contribute theoretically to the development of meaningful modeling tasks and practically to curriculum designers and mathematics teachers in schools.

The contributions of this study include theoretical implications by expanding the literature on the implementation of authentic contexts in mathematical modeling for geometry learning, as well as practical implications by providing examples of authentic modeling task designs that can be implemented in classrooms to facilitate students' mathematical thinking skills in a way that is more integrated with everyday life.

2. METHOD

Research Design and Approach

This study employed a qualitative approach with an exploratory–descriptive research design within the field of mathematics education, particularly focusing on mathematical modeling based on authentic contexts. This approach was selected because the aim of the study was not to test the effectiveness of a specific instructional treatment, but rather to explore and describe in depth the potential of residential floor tiling as a source of mathematical modeling for geometry learning at the junior high school level. The study emphasizes the identification of authentic contexts, the analysis of embedded mathematical concepts, and the stages of the mathematical modeling process that can be developed from real-life situations.

Research Object and Context

The object of this study was a subsidized house type 36 located in the Citra Latambaga Housing Complex, Latambaga District, Kolaka Regency. The house has a total building area of 36 m² with main dimensions of 6 × 6 meters. This object was selected because subsidized housing represents a common residential type in the community and is closely related to junior high school students' everyday experiences, making it a relevant and meaningful context for mathematics learning.

Specifically, the spatial layout of the type 36 house analyzed in this study consists of:

1. Two bedrooms, each measuring 3 × 3 meters;
2. One front veranda measuring 1 × 3 meters;
3. One bathroom measuring 1.2 × 1.5 meters;
4. The remaining area functioning as a living or family room.

This spatial division served as the basis for identifying variations in floor shapes, surface areas, and different floor tiling requirements for each room.

Research Focus

The primary focus of this study was residential floor tiling analyzed from the perspective of mathematical modeling in junior high school geometry learning. Specifically, the study focused on:

1. Identifying mathematical concepts, particularly geometry-related concepts, embedded in floor tiling activities in a type 36 house;
2. Analyzing the mathematical modeling processes that can be developed from the floor tiling context, including problem understanding, model formulation, model solution, and interpretation of results;
3. Examining the potential of the floor tiling context to support contextual and meaningful geometry learning for junior high school students.

Data Collection Techniques

Data were collected using the following techniques:

Contextual Observation

Observations were conducted on the structural features of the type 36 house, including room dimensions, floor shapes, and possible variations in tile sizes and materials. This observation aimed to obtain an authentic depiction of the floor tiling context to be analyzed mathematically.

Document Analysis

Document analysis involved collecting data such as house floor plans, building dimensions, and general specifications of subsidized type 36 housing. These documents served as the basis for area calculations, tile quantity estimations, and mathematical model analyses.

Mathematical Conceptual Analysis

This analysis was conducted by examining each room to identify relevant mathematical concepts, such as the area of plane figures, size ratios, unit conversion, tile quantity estimation, and potential tile cutting waste.

Data Analysis Techniques

Data analysis was conducted qualitatively through the following stages:

1. Identification of Contextual Problems
   The researcher identified real-life problems arising from the floor tiling activities of the type 36 house, such as determining the number of tiles required for each room based on specific tile sizes.
2. Mathematical Model Formulation
   At this stage, contextual problems were translated into mathematical models, for example by applying area formulas for plane figures and calculating ratios between floor area and tile area.

3. Model Solution
   The formulated mathematical models were then solved to obtain results such as the number of tiles required, material estimates, and possible solution variations based on different tile sizes.
4. Model Interpretation and Reflection
   The results of the model solutions were interpreted back into the context of residential floor tiling. At this stage, the meaning of the calculations and their implications for decision-making in geometry learning were analyzed.

Trustworthiness of Data

The trustworthiness of the data was ensured through technique triangulation by comparing findings from observations, document analysis, and mathematical conceptual analysis. In addition, consistency checks of calculations and the alignment between mathematical models and the real context of the type 36 house were conducted to ensure the validity of the analysis.

Relevance to Junior High School Learning

All stages of analysis in this study were aligned with junior high school geometry competencies, particularly topics related to the area of plane figures, ratios, and contextual problem solving. Therefore, the findings of this study are expected to provide a solid foundation for developing authentic mathematical modeling tasks based on residential floor tiling that are relevant and applicable in junior high school geometry learning.

3. RESULTS AND DISCUSSION

3.1. Results

This study yielded key findings identifying residential floor tiling in a type 36 house as a rich mathematical modeling context containing geometry concepts that are relevant for junior high school learning. The results are presented based on the analysis of the building structure, mathematical calculations related to floor tiling, and the stages of mathematical modeling that can be developed from this context.

1. Floor Area Analysis of the Type 36 House

Based on observation and document analysis, the subsidized type 36 house has a main building area of 6×6 meters, or 36 m^2. The spatial layout produces several floor surfaces with different sizes and characteristics, as follows:

- Two bedrooms, each measuring 3×3 meters, resulting in an area of 9 m^2 per room and a total bedroom area of 18 m^2;
- One front veranda measuring 1×3 meters with an area of 3 m^2;
- One bathroom measuring 1.2×1.5 meters with an area of 1.8 m^2;
- The remaining building area functions as a living or family room with an area of 13.2 m^2.

The differences in size and shape of floor surfaces across rooms indicate that floor tiling does not involve a single area calculation, but rather requires an understanding of multiple plane figures with varying dimensions.

2. Identification of Mathematical Concepts in Floor Tiling

The analysis revealed that floor tiling activities involve various mathematical concepts aligned with the junior high school geometry curriculum, including:

1. Area concepts of square and rectangular plane figures;
2. Arithmetic operations and rounding;
3. Ratios between floor area and tile area;
4. Unit conversion of length and area measurements;
5. Estimation of the number of tiles and potential cutting waste.

These concepts emerge naturally when students are confronted with problems involving the determination of tile quantities based on different tile sizes.

3. Mathematical Modeling Results Based on Tile Size Variations

This study analyzed several commonly used tile sizes, namely 40 × 40 cm, 50 × 50 cm, 60 × 60 cm, and 60 × 120 cm. Each tile size resulted in a different number of required tiles for the same room. For example, for a bedroom with an area of 9 m^2:

- The use of 40 × 40 cm tiles resulted in a higher number of tiles compared to larger tile sizes;
- The use of larger tiles, such as 60 × 60 cm or 60 × 120 cm, required fewer tiles but introduced considerations related to tile cutting waste.

These variations demonstrate that a single contextual problem can lead to multiple mathematical solutions depending on the assumptions and parameters applied.

4. Identified Stages of Mathematical Modeling

From the analysis of the residential floor tiling context in the type 36 house, four stages of mathematical modeling that can be developed in junior high school learning were identified:

1. Understanding the contextual problem (identifying the room to be tiled and its dimensions);
2. Formulating the mathematical model (calculating the floor area and tile area);
3. Solving the model (determining the required number of tiles);
4. Interpreting the solution (evaluating the calculation results within the real-life context of floor tiling).

These stages indicate that residential floor tiling can serve as a complete and systematic mathematical modeling context for geometry learning.

3.2. Discussion

The findings of this study indicate that residential floor tiling in a type 36 house constitutes an authentic context rich in mathematical content, particularly geometry-related concepts, and has strong potential as a medium for mathematical modeling in junior high school learning. These findings are consistent with international research emphasizing that real-life contexts closely connected to students' experiences enhance the meaningfulness of mathematics learning and students' mathematical modeling competencies (Blum & Borromeo Ferri, 2020; Kaiser et al., 2023).

1. Alignment of the Floor Tiling Context with Mathematical Modeling Theory

The stages of mathematical modeling identified in this study, understanding the contextual problem, formulating a mathematical model, solving the model, and interpreting the solution—are aligned with the mathematical modeling cycle proposed by Blum and Leiß (2020). In the context of floor tiling, students are confronted with real-world problems such as determining the number of tiles required based on room dimensions and tile sizes, which requires them to simplify real situations into relevant mathematical models.

Furthermore, Kaiser et al. (2023) reported that modeling tasks grounded in realistic contexts, such as spatial design and material usage, facilitate the process of mathematization more effectively than abstract tasks. This supports the findings of the present study, demonstrating that residential floor tiling can function as a complete mathematical modeling context rather than merely serving as an illustrative example of mathematical concepts.

2. Floor Tiling and Contextual Geometry Learning

The results of this study show that concepts such as area of plane figures, ratios, and estimation naturally emerge within the floor tiling context. This finding aligns with the study by Stylianides and Stylianides (2021), which suggests that geometry learning becomes more meaningful when formal concepts are connected to authentic spatial activities. Similarly, Boaler (2022) emphasizes that everyday-life contexts support students in developing deeper conceptual understanding of geometric ideas.

At the junior high school level, Schukajlow et al. (2021) found that the use of authentic contexts in geometry learning increases student engagement and improves the quality of their mathematical reasoning. This is consistent with the present study, where variations in tile sizes and room shapes encouraged students to think critically and consider multiple solution strategies.

3. Solution Variability and Mathematical Decision-Making

One important finding of this study is the variability in the number of required tiles resulting from differences in tile sizes. This reinforces the view that mathematical modeling does not necessarily lead to a single correct solution. Stillman et al. (2020) argue that modeling tasks allowing multiple solutions enhance students' mathematical decision-making skills and reflective thinking about the solutions obtained.

Moreover, Schukajlow and Krug (2022) highlight that contexts involving choices, such as material size selection or efficiency considerations—are particularly effective in developing students' mathematical literacy and evaluative skills. In this study, the context of selecting tile sizes provided opportunities for students to compare calculation results and evaluate solutions rationally.

4. Contribution to the Literature on Mathematical Modeling in Junior High School

Unlike previous studies that have predominantly employed general contexts such as financial or environmental problems, this study extends the body of research on mathematical modeling by introducing a residential context, specifically floor tiling activities. This finding complements the work of Borromeo Ferri (2021), who emphasized the importance of exploring new contexts closely related to students' everyday lives to prevent mathematical modeling tasks from becoming repetitive and monotonous.

In addition, this study confirms that residential contexts can serve as rich and realistic sources for mathematics learning, as also demonstrated by Frejd and Ärlebäck (2020) in their research on the use of simple design and construction contexts in school mathematics.

5. Theoretical and Practical Implications

Theoretically, the findings of this study strengthen the literature suggesting that mathematical modeling based on authentic contexts enhances the quality of geometry learning. Practically, these findings offer an alternative learning context that is easily accessible to junior high school teachers without requiring special facilities. Therefore, residential floor tiling can be used as a concrete example of a mathematical modeling task that is relevant, realistic, and applicable in junior high school geometry instruction.

4. CONCLUSION

This study concludes that residential floor tiling in a type 36 house represents an authentic context rich in mathematical concepts and has strong potential as a mathematical modeling context for geometry learning at the junior high school level. Floor tiling activities naturally involve geometry-related concepts such as the area of plane figures, ratios, unit conversion, estimation, and mathematical decision-making, all of which are aligned with the junior high school mathematics curriculum. This context enables students to connect mathematical concepts with real-life situations, thereby making geometry learning more meaningful and applicable.

Furthermore, residential floor tiling allows for the development of a complete mathematical modeling process, ranging from understanding contextual problems, formulating and solving mathematical models, to interpreting solutions within a real-world context. Variations in tile sizes and types generate multiple mathematical solutions, encouraging students to think critically and reflectively when making decisions. Therefore, residential floor tiling can be recommended as an alternative mathematical modeling–based geometry learning context that is relevant and easily implemented at the junior high school level.

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