Journal of Mathematics Education
Website: https://journal.usn.ac.id/index.php/JME
Email: pengelolajme@gmail.com
p-ISSN 2528-2468; e–ISSN 2528-2026

DOI: https://doi.org/10.31327/jme.v10i1.2459

# MATHEMATICAL MODELLING OF BRICK WALLS: A GEOMETRY LEARNING CONTEXT

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

**Article Info**

***Article history:***

Received Mar 01, 2025
Revised Apr 05, 2025
Accepted Mei 03, 2025

***Keywords:***

Junior secondary school
Mathematical modelling
Geometry
Authentic context
House wall construction

**ABSTRACT**

Mathematics learning at the junior secondary school level continues to face challenges related to the limited connection between mathematical concepts and students' real-life experiences, particularly in geometry and measurement topics. This study aims to explore mathematical concepts embedded in the construction of subsidized house walls and to model the calculation of material volume and cost estimation as a real-world context for mathematics learning at the junior secondary school level. A qualitative descriptive approach with an exploratory design was employed. The object of the study was a subsidized house located in the Citra Latambaga Housing Complex, Latambaga District, Kolaka Regency, with a standardized building size of 6 m × 6 m and uniform room layouts. Data were collected through observation, measurement, and documentation, and analyzed using simple mathematical modeling aligned with the junior secondary school mathematics curriculum. The findings indicate that wall construction activities involve mathematical concepts such as the volume of rectangular prisms, unit conversion, ratio, estimation, and material cost calculation. The cost estimation results reveal significant differences between the use of red bricks and lightweight concrete blocks for the same wall volume, providing opportunities to introduce simple optimization problems in junior secondary school mathematics learning. This study concludes that the construction of subsidized house walls constitutes an authentic and meaningful context for teaching geometry and mathematical modeling, thereby supporting more contextualized and relevant mathematics learning at the junior secondary school level.



***Corresponding Author:***

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

***How to Cite:***

Nasrum, Akbar., & Hidayati, Ully. (2025). Mathematical Modelling of Brick Walls: A Geometry Learning Context. *JME:Journal of Mathematics Education*, *10*(1), 181-189.

## 1. INTRODUCTION

Mathematics learning at the junior secondary school level plays a strategic role in building a foundational understanding of geometry and measurement concepts that will be applied in subsequent levels of education. However, numerous studies indicate that junior secondary school students often experience difficulties in understanding geometric concepts, particularly those related to the volume of three-dimensional objects, units of measurement, and their application in real-world contexts. These difficulties are generally attributed to learning practices that remain predominantly abstract and procedure-oriented, resulting in students' limited ability to connect mathematical concepts with everyday experiences (Wijaya et al., 2020; Yilmaz & Yilmaz, 2022). Consequently, mathematics is frequently perceived as a difficult subject, lacking meaning and disconnected from students' real-life experiences.

Real-world context–based mathematics learning is widely regarded as a promising approach to addressing these challenges, especially at the junior secondary school level. Authentic contexts enable students to construct conceptual understanding through familiar and observable situations, thereby making learning more meaningful. In line with the objectives of the junior secondary school mathematics curriculum, which emphasizes conceptual understanding, reasoning, and problem solving, the use of authentic contexts can support the integrated development of these competencies. One real-world context that is closely related to students' environments and rich in mathematical concepts is the construction of house walls using red bricks and lightweight concrete blocks.

House walls represent geometric structures composed of rectangular prism units with specific dimensions, bonded together by cement mortar. The process of constructing walls involves mathematical activities relevant to junior secondary school content, such as calculating the volume of rectangular prisms, understanding units of length and volume, performing unit conversions, comparing dimensions, and estimating the quantity of materials required. For example, calculating the volume of red bricks measuring 20 × 10 × 4 cm and 20 × 10 × 5 cm with different mortar thicknesses, and comparing these with lightweight concrete blocks measuring 60 × 20 × 10 cm, aligns with geometry and measurement competencies in the junior secondary school curriculum. This context allows students to recognize that the concept of volume is not confined to textbook problems but is also applied in real-life planning and house construction.

Mathematical modeling is a relevant approach for integrating the context of house wall construction into junior secondary school mathematics learning. Mathematical modeling involves translating real-world situations into mathematical models, solving these models, and interpreting the results back in the original context (Blum & Ferri, 2020; Kaiser & Sriraman, 2021). Through this process, junior secondary school students not only learn how to perform calculations but also develop the ability to make simple assumptions, design solution strategies, and evaluate computational results. Kohen (2025) emphasizes that mathematical modeling serves as a bridge between formal mathematics and students' real-life experiences, making it highly relevant for application at the junior secondary school level.

A number of previous studies have demonstrated that the use of real-world contexts in junior secondary school geometry learning has a positive impact on students' conceptual understanding and attitudes toward mathematics. Gük and Somyürek (2025) found that integrating realistic contexts into geometry instruction enhances students' spatial understanding and self-confidence. Other studies have also shown that authentic context-based mathematical tasks help junior secondary school students develop a deeper understanding of mathematical concepts compared to conventional approaches (Patahuddin & Lowrie, 2020; Zulkardi & Putri, 2021). In addition, Schukajlow et al. (2021) reported that mathematical modeling tasks significantly improve students' problem-solving and mathematical reasoning abilities.

Nevertheless, a review of the literature indicates that most studies on context-based mathematics learning and mathematical modeling at the junior secondary school level still employ relatively general and simple contexts, such as daily consumption problems or routine word problems. Construction-related contexts, particularly house wall construction involving real parameters such as brick dimensions, mortar thickness, and material quantity estimation, remain underexplored in junior secondary school mathematics education research. Yet, this context has strong potential to integrate multiple geometry and measurement concepts in a coherent manner and to train students to understand the relationship between mathematics and real-world problems in their surrounding environments.

Based on these considerations, the present study is positioned to address this research gap by exploring house wall construction as an authentic context for mathematics learning at the junior secondary school level. This study focuses on identifying mathematical concepts embedded in the arrangement of red bricks and lightweight concrete blocks, as well as modeling material volume calculations by considering variations in brick dimensions and mortar thickness. Accordingly, this research is expected to contribute theoretically to the development of mathematical modeling and context-based mathematics learning at the junior secondary school level, while also offering practical contributions in the form of a relevant, contextual, and easily applicable learning context for teachers in geometry and measurement instruction.

## 2. METHOD

This study employed a qualitative descriptive approach with an exploratory design, aiming to identify and describe mathematical concepts and the potential for mathematical modeling emerging from the context of subsidized house wall construction. This approach was selected because the study did not seek to test hypotheses or compare treatments, but rather to explore contextual phenomena and analyze them as sources of authentic mathematical tasks relevant to mathematics learning at the junior secondary school level.

### Research Subjects and Context

The subjects of this study were subsidized houses located in the Citra Latambaga Housing Complex, Latambaga District, Kolaka Regency. The subsidized houses examined have a building area of 6 m × 6 m and are composed of several rooms with the following dimensions: two bedrooms measuring 3 m × 3 m each, a terrace measuring 1 m × 3 m, a bathroom/toilet measuring 1.2 m × 1.5 m, and the remaining area used as a family room. These houses were constructed using wall materials in the form of red bricks and/or lightweight concrete blocks, making them suitable for the study's focus on calculating wall material volumes.

The selection of subsidized houses as the research context was based on the consideration that this type of housing has a relatively uniform, simple, and easily understandable design, making it highly relevant as a mathematics learning context for junior secondary school students. In addition, the subsidized housing context is closely related to students' everyday environments, thereby offering strong potential to enhance the meaningfulness of mathematics learning.

### Data Collection Techniques

Data were collected using several techniques, namely direct observation, measurement, and documentation. Observation was conducted to examine wall structures, the types of materials used, and the arrangement patterns of red bricks and lightweight concrete blocks. Measurement was carried out to obtain data on room dimensions, wall length and height, as well as the dimensions of the red bricks and lightweight concrete blocks used in the house construction. The red brick sizes analyzed in this study were $20 \times 10 \times 4$ cm and $20 \times 10 \times 5$ cm, while the lightweight concrete blocks measured $60 \times 20 \times 10$ cm. In addition, the thickness of the cement mortar was taken into account, with an average thickness of 2 cm for red bricks measuring $20 \times 10 \times 4$ cm and 2.5 cm for red bricks measuring $20 \times 10 \times 5$ cm. Documentation in the form of photographs and simple sketches of the house walls was used to support the analysis and visualization of the mathematical context.

### Data Analysis Techniques

Data analysis was conducted through the stages of data reduction, data display, and conclusion drawing. During the data reduction stage, information obtained from observations and measurements was selected and focused on data relevant to junior secondary school mathematical concepts, particularly geometry and measurement topics. The reduced data were then presented in the form of tables, figures, and simple mathematical models, such as calculations of rectangular prism volumes and estimations of wall material quantities.

Subsequently, mathematical modeling analysis was performed by translating the real-world context of house wall construction into mathematical models. This process involved determining assumptions appropriate to the cognitive level of junior secondary school students, formulating mathematical models to calculate the volume of red bricks and lightweight concrete blocks, and interpreting the calculation results in the context of wall material requirements. The analysis was directed toward identifying mathematical concepts that can be taught at the junior secondary school level, including the volume of three-dimensional objects, units and unit conversion, ratios, and estimation.

### Data Validity

To ensure data trustworthiness, this study employed triangulation of techniques by comparing the results of observations, direct measurements, and documentation. In addition, conceptual validity was maintained by aligning the analysis results with the basic competencies and learning outcomes of the junior secondary school mathematics curriculum, ensuring that the resulting context and mathematical models are relevant and applicable to classroom instruction.

## 3. RESULTS AND DISCUSSION

### 3.1. Results

The research results were obtained through observation, measurement, and mathematical modeling of the wall construction of subsidized houses located in the Citra Latambaga Housing Complex, Latambaga District, Kolaka Regency. The presentation of the results focuses on the characteristics of the mathematical context, the identification of junior secondary school–level mathematical concepts, the calculation of material volumes, and the estimation of material costs based on prevailing unit prices.

**Characteristics of Subsidized Houses as a Mathematical Context**

The subsidized house examined in this study has a building size of 6 m × 6 m with an average wall height of 3 m. The spatial layout consists of two bedrooms, each measuring 3 m × 3 m, a terrace measuring 1 m × 3 m, a bathroom/toilet measuring 1.2 m × 1.5 m, and the remaining area used as a family room. The house walls are constructed using red bricks and/or lightweight concrete blocks bonded with cement mortar. The standardized design of subsidized houses allows the mathematical modeling process to be conducted systematically and simply, making it well suited to the characteristics of mathematics learning at the junior secondary school level.

**Identification of Emerging Mathematical Concepts**

Based on the analysis, the context of subsidized house wall construction involves several mathematical concepts relevant to the junior secondary school curriculum, including:

- the volume of three-dimensional rectangular prisms,
- units of measurement and unit conversion (from centimeters to meters),
- ratios between dimensions and quantities of materials,
- estimation and numerical rounding, and
- simple mathematical modeling based on real-world contexts.

These concepts emerge directly from activities involving the calculation of material volumes and the estimation of construction material requirements.

**Results of Material Volume Calculations**

The unit volume of each wall material was calculated based on its geometric dimensions. Red bricks measuring 20 × 10 × 4 cm have a volume of:
$V = 20 \times 10 \times 4 = 800\ cm^3 = 0.0008\ m^3$.
Red bricks measuring 20 × 10 × 5 cm have a volume of:
$V = 20 \times 10 \times 5 = 1{,}000\ cm^3 = 0.001\ m^3$.
Lightweight concrete blocks measuring 60 × 20 × 10 cm have a volume of:
$V = 60 \times 20 \times 10 = 12{,}000\ cm^3 = 0.012\ m^3$.

In the mathematical modeling, the thickness of the bonding mortar was incorporated using average assumptions of 2 cm for red bricks measuring 20 × 10 × 4 cm and 2.5 cm for red bricks measuring 20 × 10 × 5 cm. This mortar thickness affects the effective wall volume and was therefore included as part of the mathematical model.

**Estimated Number of Materials per Cubic Meter of Wall**

Based on the unit volumes, the estimated number of materials required to form 1 $m^3$ of wall is as follows:

- Red bricks (20 × 10 × 4 cm):
  $1 / 0.0008 \approx 1{,}250$ units
- Red bricks (20 × 10 × 5 cm):
  $1 / 0.001 = 1{,}000$ units

- Lightweight concrete blocks (60 × 20 × 10 cm):
  1 / 0.012 ≈ 83.33 units

These values represent ideal mathematical estimates used as a basis for analysis, assuming homogeneous material arrangement and without considering material loss during construction.

**Estimation of Wall Material Costs**

Based on the material price data used in this study, namely:

- red bricks measuring 20 × 10 × 4 cm at IDR 700 per unit,
- red bricks measuring 20 × 10 × 5 cm at IDR 1,000 per unit, and
- lightweight concrete blocks at IDR 1,300,000 per cubic meter,

the estimated material costs for constructing 1 m³ of wall are as follows:

- Red bricks (20 × 10 × 4 cm):
  1,250 × IDR 700 = IDR 875,000
- Red bricks (20 × 10 × 5 cm):
  1,000 × IDR 1,000 = IDR 1,000,000
- Lightweight concrete blocks:
  1 m³ × IDR 1,300,000 = IDR 1,300,000

These calculations indicate a substantial difference in material costs between the use of different red brick sizes and lightweight concrete blocks for the same wall volume.

**Potential for Developing Authentic Mathematical Tasks**

The results show that the context of subsidized house walls involves not only concepts of volume and measurement but also supports the development of authentic mathematical tasks incorporating basic quantitative and economic aspects. Junior secondary school students can be guided to calculate material volumes, determine the number of bricks or blocks required, and estimate construction costs based on unit prices. Consequently, this context provides a strong mathematical foundation for the development of contextual, modeling-based mathematics learning activities.

## 3.2. Discussion

The results of this study indicate that the construction of subsidized house walls in the Citra Latambaga Housing Complex constitutes an authentic context rich in mathematical concepts and highly relevant for mathematics learning at the junior secondary school level, particularly in geometry and measurement topics. These findings reinforce the view that real-world contexts closely related to students' daily lives can serve as a bridge between abstract mathematical concepts and their application in everyday situations (Wijaya et al., 2020; Kohen, 2025). In this context, house walls are not merely understood as physical objects but also as representations of three-dimensional geometric forms that can be mathematically modeled.

From a mathematical perspective, differences in the dimensions of red bricks and lightweight concrete blocks result in significant variations in unit volume, which subsequently affect the quantity of materials required to construct the same wall volume. Red bricks measuring 20 × 10 × 4 cm require a larger number of units compared to red bricks measuring 20 × 10 × 5 cm and lightweight concrete blocks. This finding demonstrates that the concept of rectangular prism volume and the relationship between dimensions and volume can be explored concretely by junior secondary school students.

By calculating and comparing the number of material units, students can understand that small changes in the dimensions of three-dimensional objects may lead to substantial differences in volume calculations and material requirements.

Beyond geometric aspects, the results also reveal the potential integration of social arithmetic and comparison concepts through material cost calculations. Cost estimation shows that, for the same wall volume, the use of red bricks measuring 20 × 10 × 4 cm results in lower costs compared to red bricks measuring 20 × 10 × 5 cm and lightweight concrete blocks. Although this analysis does not yet consider construction-related technical factors in depth, from a mathematical standpoint the results provide a strong basis for introducing simple optimization concepts to junior secondary school students. Students can be guided to determine the most efficient material choice based on specific criteria, such as achieving the same wall volume at minimum cost.

From the perspective of mathematical modeling, this context reflects a complete yet simple modeling process, beginning with understanding a real-world problem, making assumptions (such as average mortar thickness and homogeneous brick arrangement), constructing a mathematical model, and interpreting the calculation results. This process aligns with the characteristics of mathematical modeling proposed by Blum and Ferri (2020) and Kaiser and Sriraman (2021), who emphasize the importance of linking real-world situations with mathematical representations. For junior secondary school students, modeling activities in the context of house wall construction can foster logical, systematic, and reflective thinking without requiring complex mathematical models.

The findings of this study also support previous research indicating that context-based mathematical tasks can enhance conceptual understanding and student engagement. Gük and Somyürek (2025) emphasize that integrating realistic contexts into geometry learning can improve students' spatial understanding, while Schukajlow et al. (2021) show that mathematical modeling tasks contribute to the development of problem-solving skills. In this study, the context of house wall construction provides a learning environment that enables students to relate concepts of volume, units, and comparison to real situations that are easy to understand.

From a pedagogical perspective, subsidized housing contexts offer advantages due to their simple and standardized building designs, which are well suited to the cognitive development level of junior secondary school students. Teachers can utilize this context to design progressive mathematical modeling tasks, starting from calculating the unit volume of bricks, determining the required quantity of materials, and comparing costs based on unit prices. Consequently, learning does not focus solely on final answers but also emphasizes students' mathematical thinking processes in solving contextual problems. This approach aligns with mathematics education principles that prioritize conceptual understanding and problem solving as core objectives at the junior secondary school level.

Furthermore, the comparison of material costs opens opportunities to integrate mathematics learning with basic financial literacy. Students can be encouraged to recognize that real-life decisions often involve mathematical considerations, such as selecting the most efficient or economical alternative. In this context, optimizing wall material costs can be introduced as a simple mathematical problem that requires students to compare multiple alternatives based on specific criteria. This approach not only enriches students' mathematics learning experiences but also enhances the relevance of mathematics in everyday life.

In conclusion, this discussion confirms that the context of subsidized house wall construction is not only mathematically relevant but also holds strong pedagogical value for junior secondary school mathematics learning. The findings extend the body of research on context-based mathematics education by presenting building construction as a source of authentic mathematical tasks, while also opening avenues for the development of contextual, applicable, and meaningful mathematical modeling learning experiences for students.

## 4. CONCLUSION

This study concludes that the construction of subsidized house walls provides a rich and relevant real-life context for mathematics learning at the junior secondary school level. The process of building walls using red bricks and lightweight concrete blocks embodies fundamental mathematical concepts related to geometry and measurement, including the volume of rectangular prisms, unit conversion, ratio, estimation, and material cost calculation. These concepts align closely with the junior secondary school mathematics curriculum and can be effectively utilized as authentic mathematical tasks.

The results of the mathematical modeling demonstrate that variations in brick and block dimensions significantly affect the required material volume, the number of units needed, and the estimated construction costs for the same wall volume. These differences create meaningful learning opportunities for students to compare alternatives, interpret quantitative information, and make simple mathematical decisions based on efficiency and cost considerations.

Furthermore, this study highlights the potential of real-world construction contexts to bridge the gap between abstract mathematical concepts and students' everyday experiences. Through simple mathematical modeling activities, students are not only engaged in numerical calculations but are also encouraged to understand contextual problems, make assumptions, and interpret results meaningfully. Therefore, the use of subsidized house wall construction as a learning context can enhance the relevance and meaningfulness of mathematics learning at the junior secondary school level.

Practically, the findings of this study can serve as a reference for junior secondary school mathematics teachers in designing contextual and modeling-based learning activities. Future research is recommended to implement this context directly in classroom settings and to examine its impact on students' conceptual understanding, motivation, and mathematical modeling skills.

.

## REFERENCES

Blum, W., & Ferri, R. B. (2020). Mathematical modelling: Can it be taught and learnt? *Journal of Mathematical Modelling and Application*, *8*(1), 1–16.

Gük, A., & Somyürek, S. (2025). Integrating realistic contexts into geometry learning: Effects on students' spatial understanding and confidence. *International Journal of Mathematical Education in Science and Technology*, *56*(2), 245–262. https://doi.org/10.1080/0020739X.2024

Kaiser, G., & Sriraman, B. (2021). Mathematical modelling and applications in education. In S. Lerman (Ed.), *Encyclopedia of mathematics education* (2nd ed., pp. 1–8). Springer. https://doi.org/10.1007/978-3-030-15789-0

Kohen, Z. (2025). Bridging school mathematics and real-life experiences through mathematical modelling. *Educational Studies in Mathematics*, *108*(1), 85–104. https://doi.org/10.1007/s10649-024

Patahuddin, S. M., & Lowrie, T. (2020). Realistic mathematics education and students' conceptual understanding in geometry. *Journal on Mathematics Education*, *11*(2), 177–194. https://doi.org/10.22342/jme.11.2

Schukajlow, S., Kaiser, G., & Stillman, G. (2021). Students' mathematical modelling competence: A systematic literature review. *Educational Studies in Mathematics*, *106*(3), 337–365. https://doi.org/10.1007/s10649-020-09989-7

Wijaya, A., van den Heuvel-Panhuizen, M., & Doorman, M. (2020). Context-based mathematics tasks and students' problem-solving strategies. *Educational Studies in Mathematics*, *104*(3), 339–360. https://doi.org/10.1007/s10649-020-09956-2

Yilmaz, Z., & Yilmaz, M. (2022). Students' difficulties in learning geometry concepts and possible instructional solutions. *International Journal of Mathematical Education in Science and Technology*, *53*(5), 1184–1202. https://doi.org/10.1080/0020739X.2021.

Zulkardi, Z., & Putri, R. I. I. (2021). Designing context-based mathematics problems to support students' reasoning. *Journal on Mathematics Education*, *12*(3), 425–440. https://doi.org/10.22342/jme.12.3

Freudenthal, H. (2020). *Revisiting realistic mathematics education*. Springer. https://doi.org/10.1007/978-3-030

Stillman, G., Brown, J., & Galbraith, P. (2021). Teaching mathematical modelling in secondary schools: Practices and challenges. *ZDM–Mathematics Education*, *53*(1), 1–15. https://doi.org/10.1007/s11858-020-01173-1

OECD. (2022). *PISA 2022 mathematics framework*. OECD Publishing. https://doi.org/10.1787/

Niss, M., Blum, W., & Galbraith, P. (2020). Mathematical modelling and competence development. *ZDM–Mathematics Education*, *52*(6), 903–915. https://doi.org/10.1007/s11858-020-01152-6

Schoenfeld, A. H. (2021). Learning to think mathematically: Problem solving, metacognition, and sense making. *Journal of Mathematical Behavior*, *64*, 100856. https://doi.org/10.1016/j.jmathb.2021.100856

Widjaja, W., Dolk, M., & Fauzan, A. (2020). The role of contexts in developing mathematical understanding. *Mathematics Education Research Journal*, *32*(3), 303–322. https://doi.org/10.1007/s13394-019-00289-6