

APPLYING THE PRINCIPLES OF REALISTIC MATHEMATICS EDUCATION TO DESIGN WORD EXERCISES INTEGRATING MORAL EDUCATION THEMES FOR FIFTH-GRADE STUDENTS

Tran Le Ha Mi, Hoang Thu Phuong, Nguyen Anh Tu and Luu Tra My *

Faculty of Primary Education, Hanoi National University of Education, Hanoi city, Vietnam

*Corresponding author: Luu Tra My, e-mail: tramy@hnue.edu.vn

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Abstract. This paper investigates the application of Realistic Mathematics Education (RME) principles in designing word exercises that integrate selected moral education themes for fifth-grade students. Mathematics not only fosters logical thinking but can also serve as a medium for cultivating positive moral values, particularly when word exercises are embedded in meaningful and relatable situations. The primary objective of this study is to develop a structured design process for such problems based on RME principles, while also broadening the scope of RME by incorporating moral education into mathematics instruction.

Keywords: Realistic Mathematics Education (RME), word problem design, moral education, fifth-grade students.

1. Introduction

Mathematics not only supports the development of logical thinking and problem-solving skills but also serves as an effective tool for fostering students' moral qualities. However, this potential can only be fully realized when appropriately embedded in both teaching content and instructional methods. In particular, word problems - when situated in realistic contexts - offer significant potential for integrating moral education, thereby contributing to the formation of personality traits in primary school students, who are at a critical stage of emotional, social, and moral development [1].

Within the context of comprehensive educational reform, the current goal of primary education in Vietnam is to foster the holistic development of students' competencies and moral qualities. This objective is clearly articulated in the 2018 General Education Curriculum issued by the Ministry of Education and Training, which emphasizes that education extends beyond the transmission of knowledge and skills to include the cultivation of moral values, lifestyle habits, and essential life competencies. Accordingly, integrated education aimed at developing students in a well-rounded manner has become both an urgent need and an inevitable trend in contemporary educational practice.

The theory of Realistic Mathematics Education (RME) was first developed in the Netherlands in the 1970s and has since gained international recognition and application across various educational contexts [2]. This approach helps students develop mathematical thinking and problem-solving skills. Research by Freudenthal (1973), de Lange (1996), and Gravemeijer (1999) has demonstrated that this method not only enhances students' understanding of mathematical concepts but also fosters critical and creative thinking skills [3]-[5].

At the primary level, Julie et al. (2013) focused on developing instructional materials for teaching fractions to fifth-grade students using the principles of Realistic Mathematics Education (RME). Their study addressed key issues such as identifying appropriate realistic contexts for introducing the multiplication of fractions, assessing the impact of instruction on students' mathematical thinking, and designing strategies to effectively support students in constructing a conceptual understanding of fractional multiplication [6]. At the secondary level, Makonye (2014) examined the teaching of functions through the RME approach, highlighting the importance of employing multiple representations, including natural language, visual models, graphs, and mathematical symbols to enhance students' comprehension and deepen their understanding of functional relationships [7]. In more recent research, Istikomah (2020) and Ediyanto (2020), along with their collaborators, expanded the scope of RME by developing and applying electronic learning modules (e-modules) grounded in RME principles. They also evaluated the effects of RME on primary students' learning motivation and academic achievement. Collectively, these studies not only reaffirm the effectiveness of RME in improving mathematics instruction but also demonstrate its suitability and scalability across various educational levels [8].

In Vietnam, the research and application of RME theory are still in the developmental stages, particularly within the context of educational reforms aimed at developing students' competencies and personal qualities. RME theory facilitates the development of critical thinking and problem-solving skills by embedding realistic situations into mathematical learning, providing a solid foundation for integrating moral education into mathematical word problems. Early studies have primarily focused on testing the RME method in teaching mathematics at primary and secondary levels, particularly in topics such as fractions, decimals, and geometry. These studies highlight the importance of realistic contexts in facilitating students' deeper understanding of mathematical principles, rather than merely memorizing formulas and rules. Building on this foundation, Le TA & Tran C (2020) co-authored a study that critically examined the theoretical underpinnings of RME and proposed pedagogical measures suitable for Vietnam's educational context, especially in light of the 2018 curriculum reform. Their work emphasized the importance of contextualization, guided reinvention, and horizontal mathematization, while also identifying practical challenges such as teacher training and curriculum constraints [9].

In recent years, the theory of RME has been studied and applied in Vietnam as a means to enhance the effectiveness of mathematics instruction, particularly at the upper secondary level. In his doctoral dissertation, Nguyen Tien Da conducted an extensive experimental study on the integration of RME into the teaching of calculus, with the primary aim of enabling students to not only master mathematical concepts but also apply them in realistic contexts. His research focused on designing instructional activities grounded in realistic situations, thereby encouraging students to rediscover and reconstruct mathematical knowledge through contextual exploration. A five-step "mathematization" process was proposed to guide students in transforming realistic scenarios into mathematical problems, fostering their problem-solving abilities and creative thinking [10].

The implementation of these approaches was piloted in various high schools across Vietnam and demonstrated positive impacts on both students' academic performance and their interest in mathematics. Complementary to this work, Pham Xuan Chung and Pham Thi Hai Chau (2018) developed pedagogical strategies to support teachers in applying RME principles in classroom practice [11]. Meanwhile, Nguyen Tien Trung and Phan Thi Tinh provided a comprehensive academic overview of RME, positioning it not only as an educational theory but also as a curriculum development framework. These scholars emphasized that successful implementation of RME requires a shift in pedagogical approaches, along with systematic teacher training and professional development [12]. Overall, RME is regarded as a viable and necessary direction for bridging mathematics education with realistic relevance while fostering the comprehensive development of learners' mathematical competencies.

An increasing number of studies, both nationally and internationally, have demonstrated that integrating moral education into mathematics instruction can significantly enhance students' academic performance while simultaneously supporting the development of their character and ethical values. Falkenberg (2006) emphasized that mathematics education not only has the potential but should be deliberately used as a means to foster students' moral imagination and ethical awareness through well-structured mathematical activities [13]. In Malaysia, the primary mathematics curriculum explicitly incorporates moral values, allowing students to engage with mathematical content while effectively internalizing humanistic principles [14].

While previous studies highlight the significance of using RME theory in mathematics instruction, there remains a limited number of studies focused on designing word exercises based on RME principles that specifically integrate moral education topics for 5th-grade students. This study aims to develop a process for designing such word problems, based on RME principles, that integrate moral education, thereby addressing the comprehensive development needs of 5th-grade students and enriching existing research on the integration of moral education into mathematics teaching.

2. Content

2.1. Orientation for designing mathematics exercises

2.1.1. Foundations for constructing exercises

**** The five principles of Realistic Mathematics Education (RME)***

The construction of mathematics exercises should be grounded in Treffers' (1978) five principles of RME. First, phenomenological exploration emphasizes using realistic contexts to help students develop mathematical concepts through formalization and abstraction, making learning meaningful and applicable. Second, bridging by vertical instruments involves using emergent models developed from students' intuitive understanding to move gradually toward formal mathematical representation. Third, self-reliance highlights students' active role in constructing their own knowledge, encouraging creativity and independent thinking. Fourth, interactivity promotes collaborative learning through discussions and peer engagement, fostering critical thinking and self-regulation. Lastly, intertwining encourages integrating different mathematical domains and connecting them to other disciplines, helping students view mathematics as a unified, applicable system.

**** Integrated teaching of mathematics and ethics for 5th-grade students***

The development of mathematics exercises should align with the orientation of integrated teaching of Mathematics and Ethics for fifth-grade students. Integrated teaching is a prominent educational trend that aims to foster students' holistic development in both cognitive and moral domains. When designing mathematics exercises for this age group, educators should select mathematical content that can be meaningfully connected to ethical themes. This approach creates opportunities for students to simultaneously enhance their mathematical skills and internalize moral values naturally and engagingly. Ethical topics suitable for integration include environmental awareness, personal responsibility, cooperation, honesty, diligence and work ethic, respect for time, and financial literacy. Through contextualized, relatable problems, students can form a clearer understanding of life values and be encouraged to adopt appropriate behaviors in daily life. Furthermore, this integrated teaching strategy enriches lesson content, deepens students' appreciation of the interplay between mathematics and realistic contexts, and promotes the development of critical thinking and creative problem-solving abilities.

*** 2018 general education curriculum: mathematics and ethics**

The development of mathematics exercises should be grounded in the 2018 general education curriculum for mathematics and ethics. This revised curriculum clearly emphasizes the goal of fostering both students' competencies and qualities through subject-based learning. In Mathematics, the curriculum outlines the development of fundamental competencies such as problem-solving, computational proficiency, and the application of mathematical knowledge to realistic situations. In ethics, the focus is on cultivating core moral values, including responsibility, honesty, gratitude, empathy, and the ability to live harmoniously within a community [15].

*** Characteristics of math word exercises for primary school students**

Mathematics exercises must be designed to align with the characteristics of word exercises appropriate for primary school students, particularly those in Grade 5. Word exercises require students to read, comprehend, and analyze information presented in natural language, then apply suitable mathematical strategies to find solutions. Effective word exercises are characterized by clarity, coherence, and relevance to realistic contexts, while also being appropriate for the language proficiency and cognitive development of Grade 5 learners. These problems support the development of not only mathematical and computational skills but also reading comprehension, analytical thinking, and logical reasoning. For this age group, word exercises must present familiar and engaging realistic scenarios that spark curiosity and stimulate critical thinking. Additionally, problems should be appropriately scaffolded and structured, enabling students to identify key information and determine a logical path to the solution. Through such tasks, students not only acquire problem-solving skills but also enhance their capacity for logical and creative thinking.

*** Psychological characteristics of 5th-grade students**

The design of mathematics exercises should be grounded in the psychological characteristics of Grade 5 students. At approximately 10 to 11 years of age, these students are in a transitional stage between primary and secondary education, marked by notable cognitive, linguistic, and socio-emotional development. Their capacity for abstract and logical thinking becomes more pronounced, and they begin to approach problems in a more structured and systematic manner. However, their abstract thinking skills are still developing and often require support through concrete, relatable contexts. Consequently, mathematics exercises for this age group should be rooted in familiar, realistic scenarios that are easy to visualize, relevant to students' everyday experiences, and practically applicable. These exercises should be engaging, capable of arousing curiosity and a desire for exploration, while remaining appropriate for students' cognitive levels and psychological development. Furthermore, incorporating moral values into mathematics problems can support not only intellectual growth but also the formation of a strong ethical foundation, contributing to students' holistic development.

2.1.2. Principles for designing math word exercises for 5th grade students to approach the topic of moral education

*** Ensuring a close alignment with the knowledge content presented in the 5th-grade mathematics textbook**

This principle emphasizes that the design of exercises aimed at developing the competencies and qualities of Grade 5 students must be closely aligned with the content of the Grade 5 mathematics textbook. Such alignment ensures consistency and continuity with the knowledge and skills acquired in previous grades. Accordingly, the exercises must meet the standards of knowledge, skills, and attitudes as defined by the objectives of the current mathematics curriculum. A lack of alignment with the textbook content can compromise the scientific integrity

of the exercises, create challenges for students in knowledge acquisition, and hinder the development of critical thinking skills. Moreover, this principle necessitates that teachers engage with the 2018 General Education Curriculum for Mathematics, fully understanding its goals for competency and character development, as well as the system of general and subject-specific mathematical competencies. This understanding enables educators to make flexible and appropriate adjustments to instructional content, particularly when teaching Grade 5 using the current textbooks, while still adhering to the developmental objectives of the reformed curriculum. Therefore, the design of mathematics exercises must be firmly grounded in the curriculum framework. Exercises should correspond to the content of each knowledge area and lesson, as well as the overall program, to ensure the achievement of the expected levels of knowledge, skills, and competencies upon completion of the course.

**** Ensuring appropriateness to the cognitive development level of current 5th Grade students***

This principle stipulates that when designing mathematics exercises for Grade 5 students, teachers must consider both the general cognitive characteristics and the specific cognitive development levels of this age group. The selection of content and the formulation of performance expectations for each type of exercise must be appropriate and feasible in relation to students' developmental stages. Furthermore, it is essential to structure problem-solving tasks along a continuum of difficulty from lower to higher levels, corresponding to students' cognitive thresholds. This allows teachers to define suitable performance requirements for each exercise type, enabling students to gradually and effectively develop their mathematical problem-solving abilities.

Designing exercises that both align with students' cognitive capacities and foster problem-solving skills requires careful calibration. Tasks should neither be too simple nor overly complex, but instead should present an optimal level of challenge that encourages effort, engagement, and the demonstration of creativity. During instruction, teachers are encouraged to group students according to their cognitive levels. This differentiation allows for the assignment of exercises tailored to each group, thus supporting more personalized learning and fostering problem-solving development in a structured, inclusive manner.

**** Ensuring logical structure and systematic progression aligned with students' developmental levels in mathematical problem-solving ability***

Within each instructional unit, the design of mathematics exercises plays a critical role in ensuring a smooth teaching process and in effectively fostering students' problem-solving abilities. To adhere to this principle, exercises must be organized into coherent categories and subcategories, following a logical structure. Each category should be systematically sequenced from easy to difficult, and from simple to complex, so that earlier exercises provide a foundational basis upon which students can build as they approach more advanced problems. This structured progression supports cumulative learning and facilitates the gradual development of mathematical thinking and problem-solving skills.

**** Ensuring diversity and richness in content and expression, reflecting contemporary realistic contexts***

One of the key psychological characteristics of children is their intrinsic desire to explore new, engaging, and diverse experiences. Therefore, in applying the principles of Realistic Mathematics Education (RME) theory to the design of mathematics exercises, it is essential to incorporate diversity in both form and content. To implement this principle effectively, exercises should draw from a wide range of mathematical content areas and establish connections to realistic contexts and activities. Furthermore, the presentation of exercises should be flexible and varied. In addition to traditional formats using numerical or alphabetical symbols, exercises can be enriched through the integration of visual elements such as images, photographs, diagrams,

and tables. This multimodal approach enhances engagement, supports comprehension, and aligns with students' natural curiosity and diverse learning preferences.

2.2. Proposing a process for designing word exercises that integrate moral education topics for 5th-grade students

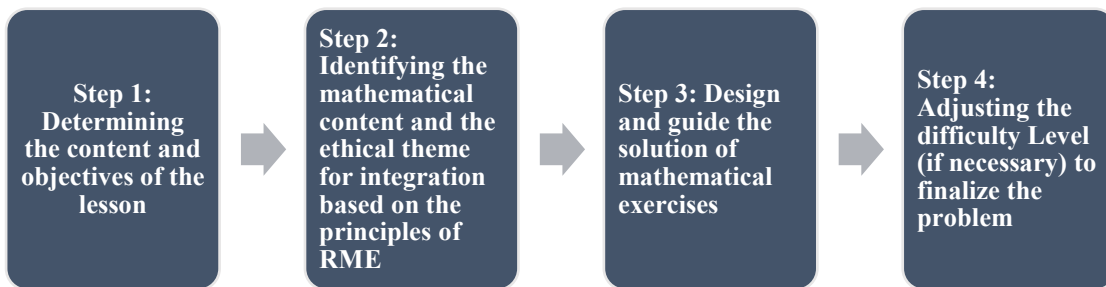


Figure 1. A four-step process for designing word exercises integrates moral education topics for 5th-grade students

Step 1: Determining the content and objectives of the lesson

Identifying the content and learning objectives is a foundational step in the design of mathematical exercises. Clearly defining the instructional goals and expected outcomes serves to guide the development of text-based math exercises and ensures alignment with the overall teaching strategy. Teachers must accurately determine the knowledge standards and learning outcomes that students are expected to achieve upon completing the lesson. In addition to specifying the new knowledge and skills to be acquired, teachers need to assess students' prior knowledge and competencies. This understanding allows educators to build on existing foundations and support students effectively in addressing various mathematical problems.

Step 2: Identifying the mathematical content and the ethical theme for integration based on the principles of RME

According to the first principle of RME, word exercises should be based on practical, meaningful situations that are closely connected to students' everyday lives. Each piece of mathematical knowledge can be linked to contexts that integrate ethical education, depending on the instructional objectives, the learning content, and students' life experiences and cultural backgrounds. Therefore, teachers must carefully study and analyze the Mathematics and Ethics curricula and textbooks to identify related knowledge areas, thereby establishing connections and forming integrated themes.

Step 3: Designing and guiding the solution of mathematical exercises

Based on the integrated theme identified in Step 2, teachers design mathematical word problems rooted in realistic ethical situations such as sharing fairly, helping others, or protecting the environment. These problems should embed relevant mathematical content (e.g., fractions, measurement, ratios) while reflecting meaningful moral contexts appropriate for fifth-grade students. According to the second principle of RME, teachers should use emergent models (e.g., bar models, number lines) to help students move from intuitive understanding to abstract representation. In guiding the solution process, teachers suggest models that support students in analyzing the situation, identifying key facts, and selecting suitable strategies. Prompts like "What do we know?", "What is fair?" or "What should we do?" can guide thinking. Teachers are encouraged to promote discussion around both mathematical reasoning and ethical implications,

helping students reflect and explain their decisions. Rather than providing direct answers, teachers foster independent thinking and moral awareness through inquiry-based learning.

Step 4: Adjust the difficulty level (if necessary) to finalize the problem

After the initial design, teachers should review and refine the problem to ensure the effective integration of mathematical knowledge with ethical values. Teachers are encouraged to pilot the exercise with students to evaluate its relevance, the clarity of the mathematical concepts, and the effectiveness of conveying the intended moral lessons. Based on this feedback, teachers can adjust the problem's context, questions, and solution pathways to better align with students' cognitive abilities while reinforcing the intended ethical messages.

2.3. Ethical themes according to the 2018 General Education Curriculum

According to the 2018 General Education Curriculum, ethical themes for Grade 5 are structured around five core moral qualities: patriotism, compassion, diligence, honesty, and responsibility. Each quality is associated with specific realistic content and learning outcomes that aim to develop students' moral awareness and appropriate behavior.

For patriotism, students learn to recognize and express gratitude to those who have contributed to the country and the community, understand the significance of national devotion, and show appreciation through respectful words and actions. Compassion is developed through understanding and respecting differences in gender, ethnicity, living conditions, and other personal traits, while also promoting empathy and inclusive behavior. Diligence focuses on overcoming difficulties, fostering perseverance, and building resilience in study and daily life. Honesty involves helping students distinguish right from wrong, develop integrity, and demonstrate the courage to defend what is just and good. Finally, responsibility (as referenced elsewhere in the curriculum) includes fulfilling duties toward oneself, family, school, and society.

These ethical themes are integrated into practical learning contexts, allowing students not only to acquire moral knowledge but also to apply it meaningfully in everyday situations, contributing to the development of well-rounded, responsible individuals.

2.4. Illustrative example

**** Problem with environmental protection***

Step 1: Determining the content and objectives of the lesson

The problem is related to an environmental protection campaign, specifically focusing on the collection and classification of waste. Students will solve a problem involving the determination of two numbers when their sum and difference are known. Additionally, they will calculate the amount of recyclable and non-recyclable waste and the amount of electricity saved through recycling.

Step 2: Identifying the mathematical content and the ethical theme for integration based on the principles of RME

Mathematics: The problem requires students to apply knowledge of the sum and difference of two numbers to solve practical problems through basic operations (addition, subtraction, multiplication).

Ethics topic: Protecting the environment (Grade 5): The problem helps students develop an awareness of environmental protection through waste classification and recycling. It also emphasizes the positive impact of recycling on resource and energy conservation.

Step 3: Designing and guiding the solution of mathematical exercises

This problem requires students to apply mathematics to a realistic situation involving waste recycling and electricity conservation. The teacher will assist students in creating a diagram to find the two numbers and calculate the amount of electricity saved from recycling waste.

Step 4: Adjusting the difficulty level (if necessary) to finalize the problem

Adapting the level of difficulty: If students encounter difficulties in constructing the diagram, teachers may provide additional scaffolding through more detailed instructions or guided steps. In cases where calculating the amount of electricity saved from recycled waste proves too complex, the problem can be simplified, or supplementary examples can be provided to clarify the concept.

Finalizing the problem design: It is essential to ensure that the problem is both comprehensible and appropriate to the cognitive level of the students. Teachers should make necessary adjustments to the context and components of the problem to reflect classroom realities while reinforcing the connection between mathematics and environmental awareness. This alignment supports both educational and ethical learning outcomes.

The following example is constructed based on the four-step process proposed by the group of authors:

*** Example**

In an environmental protection campaign, two groups of students participated in collecting and sorting waste in a park. The total amount of waste collected by the two groups was 135 kg. It is known that the first group collected 27 kg more than the second group, and 80% of the total amount of waste collected was recyclable.

- (a) How many kilograms of waste did each group collect?
- (b) Calculate the mass of recyclable waste and non-recyclable waste.
- (c) If each kg of recyclable waste saves 0.5 kWh of electricity, how much total electricity is saved?

After solving the problem, answer the following questions:

- Why is it necessary to classify and recycle waste?
- What specific actions can students take at home and at school to reduce the amount of waste released into the environment?

*** Lesson learned**

Every small action can help protect the environment, conserve resources, and create a greener world.



Figure 2. Waste management (Source: Internet)

*** Orientation for solving mathematical exercises**

- Students are guided to solve the problem by constructing a diagram based on the given data, such as the total amount of garbage collected, the difference between two groups, and the recycling rate. The use of visual models enables students to represent the problem mathematically and supports their reasoning process. Teachers should encourage students to analyze the realistic context of the problem - specifically, the collection and classification of waste - and to consider its broader implications, such as resource conservation and environmental protection.

- Teachers play a critical role in supporting students' transition from understanding a practical scenario (e.g., waste collection and sorting) to formulating and using a corresponding mathematical model. This approach aligns with the principles of RME, fostering deeper conceptual understanding through contextualized problem-solving.

Table 1. The application of the RME (Realistic Mathematics Education) principle in Example

RME principle	Description
<i>Phenomenological exploration</i>	The problem is embedded in a realistic context that is both familiar and meaningful to students—specifically, an environmental protection campaign involving garbage collection and sorting. This context enables students to connect mathematical concepts with their everyday experiences, fostering greater engagement and relevance. By situating mathematical problems within authentic scenarios, students are encouraged to move beyond rote memorization of formulas and instead apply mathematical reasoning to realistic situations, such as solving problems involving sums, differences, and percentages.
<i>Bridging by vertical instruments</i>	In solving the problem, students are guided from a practical scenario (e.g., garbage collection and sorting) toward the construction of mathematical models through fundamental operations. Relationships between total waste and recyclable waste are expressed using divisions and percentages, leading students to establish key mathematical operations such as addition, subtraction, and division. This modeling process supports students in translating realistic problems into formal mathematical language, a core tenet of the RME approach.
<i>Self-reliance: pupils' constructions and productions</i>	The problem is designed to encourage students to think independently and to propose various strategies for categorizing and dividing the data, rather than simply following a predefined method. This approach fosters experimentation, critical analysis, and comparative reasoning, as students evaluate different solution strategies to determine the most effective one. Encouraging students to construct their own methods enhances creativity, autonomy, and problem-solving abilities.
<i>Interactivity</i>	The structure of the problem facilitates peer interaction, particularly through the scenario involving waste classification by two student groups. It invites discussion, debate, and collaborative problem-solving, thereby strengthening students' mathematical communication and critical thinking skills. Teachers are encouraged to facilitate group-based activities that allow students to explore diverse approaches and collaboratively assess their effectiveness.
<i>Intertwining</i>	This problem not only facilitates the development of basic arithmetic skills but also promotes the integration of multiple mathematical domains, such as the interrelationships among fractions, percentages, and algebraic operations. Through this integrative approach, students achieve

	a deeper conceptual understanding while simultaneously engaging with the practical applications of mathematics in addressing realistic challenges, including environmental sustainability. By highlighting the relevance of mathematics to broader societal concerns, the problem encourages students to appreciate its role in everyday decision-making and civic engagement. Furthermore, it expands students' understanding of the practical applications of mathematical operations in social contexts, helping them better recognize the connection between mathematics and realistic issues.
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3. Conclusions

The RME theory, developed over the past 70 years, has significantly influenced mathematics curricula worldwide and continues to be a subject of educational research. In Vietnam, RME offers valuable potential for integrating ethics education into mathematics instruction. By applying RME principles in the design of word problems, educators can connect mathematical content with moral themes, supporting both cognitive and character development. Context-rich, realistic exercises promote critical thinking, ethical reflection, and active learning.

This study proposes a structured process for designing Grade 5 word problems that align with RME principles and embed ethical values. The process includes selecting mathematical topics, building realistic contexts, and integrating moral content. An example involving environmental protection illustrates how ethics can be meaningfully woven into mathematical problem-solving. Grounded in RME, this approach introduces an innovative teaching method that is both practical and applicable within the current Vietnamese curriculum, showing strong potential for broader adoption in primary education.

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