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Realistic Mathematics Education in the Context of Truck Tires and Marble Games in Elementary School Addition and Subtraction Material

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Abstrak

Tujuan penelitian ini yaitu untuk mendeskripsikan aktivitas siswa selama proses pembelajaran realistik berkonteks ban truk gandeng dan permainan kelereng pada materi penjumlahan dan pengurangan bilangan. Pada penelitian ini menggunakan metode *design research*. Subyek pada penelitian ini adalah siswa kelas 1 SD Negeri 3 Krasak di Kabupaten Jepara, Jawa Tengah yang terdiri dari 23 siswa. Hasil penelitian menunjukkan bahwa dengan menggunakan konteks ban truk gandeng sebagai alat peraga membuat siswa lebih aktif serta mempunyai rasa ingin tahu lebih besar untuk menyelesaikan permasalahan yang diberikan, sehingga mampu memahami dan mengerti konsep penjumlahan. Siswa dapat menggambar ulang semua ban truk kemudian melakukan perhitungan dan dicocokkan jumlah ban truk yang siswa gambar dengan jumlah ban truk yang sedang mereka amati. Siswa dapat memahami bahwa penjumlahan tersebut merupakan penggabungan dari dua bak truk gandeng. Secara keseluruhan siswa melakukan dan mengerjakan setiap aktivitas dengan baik dan benar. Melalui permainan kelereng siswa dapat melakukan belajar sambil bermain sehingga dapat mempercepat pemahaman mengenai operasi pengurangan bilangan.

Abstract

The purpose of this study is to describe students' activities during realistic mathematics learning using the context of trailer truck wheels and marble games in addition and subtraction material. This research employed a design research method with 23 first-grade students of SD Negeri 3 Krasak, Jepara Regency, Central Java as participants. The findings indicate that the use of trailer truck wheels as concrete media increased students' activeness and curiosity in understanding the concept of addition. Students were able to redraw the wheels, perform calculations, and match their drawings with real objects, leading to an understanding of addition as a process of combining. Meanwhile, through the marble game, students engaged in learning while playing and understood subtraction as the process of taking away from a whole. Overall, students actively participated and successfully completed the activities, showing that real-world contexts effectively support the understanding of basic arithmetic operations.

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Introduction

Education today requires students to always think critically in solving problems in learning, one of which is mathematics. Mathematics is a very useful subject for all students, given the increasingly modern technological developments and the urgent need for people to have logical, critical, and structured thinking skills. (Komariyah et al.,2018).

Mathematics is not new to students, but it is perceived as a very complicated subject that is difficult to understand. According to Yulianty (2019)The objectives of mathematics learning in school are for students to be able to: (1) learn mathematical theories/concepts, explain the relationship between theories/concepts and implement theories/concepts or procedures flexibly, accurately, efficiently, and appropriately in solving problems, (2) use reasoning about properties and patterns, perform mathematical manipulations when creating generalizations, constructing proofs, or explaining mathematical ideas and statements, (3) solve problems by understanding the problem, organizing the mathematical form, refining the form, and translating the solution, (4) Discussing ideas using tables, symbols, diagrams, or other media to explain situations or problems, (5) Having an attitude of valuing the meaning of mathematics in life, that is, having attention, curiosity, and interest in analyzing mathematics, as well as not easily giving up and being confident in solving problems.

Without realizing it, mathematics can be implemented in everyday life, therefore requiring a mathematical learning approach that is in line with students' thinking and activities in everyday life. A realistic mathematical learning approach is an approach that is very much needed in mathematics learning today. According toSetiawan (2020)Hans Freudentahal, a pioneer of Realistic Mathematics Education (RME), guides students to recreate mathematics using their own style.Also said bySiregar et al. (2020)The Realistic Approach is a mathematical learning approach that focuses on everyday life. The Realistic Mathematics Approach can motivate students to learn the material clearly and without absurdity. By using the realistic mathematics approach with the help of manipulative teaching aids, concrete objects, and traditional games or activities, it is possible to improve students' mathematical communication, teachers' classroom management skills, and students' interest in learning(Kanastren et al., (2018).

During the observation, teachers were still using the lecture learning model. This model makes students easily bored and less enthusiastic about learning. According to W. Setiawan (2021), most teachers still struggle to explain mathematical concepts to students virtually because they are still abstract. Furthermore, in school mathematics learning, students are primarily taught theory or definitions, then given examples, and then continued with practice problems. This learning pattern weakens students' understanding of concepts, often leading to difficulty solving math problems (Fauziah et al., 2023). Teachers often fail to master or choose the right method for delivering the material, hindering student understanding.

As a result, students tend to be less interested in learning mathematics, especially in addition and subtraction operations. According to Wiryanto(2020) Piaget emphasized that elementary school students aged 6-11 are still entering the concrete operational stage, meaning that concrete material is presented first, followed by abstract learning. Therefore, more innovative, enjoyable, and experience-based learning methods are essential for students to better understand concepts and increase their learning interest.

This research aligns with previous research by Irma et al.(2022)which demonstrated that the use of smart tree media can be an alternative concrete medium to help students understand the concept of percentages from informal to formal forms. Another study by Ningrum & Wiryanto(2022)stated that the use of the PMRI approach in the context of traditional wajik cake can foster students' understanding of the rules of addition and subtraction. Another previous study by Ni'mah et al.(2024)showed that the use of open media, the Place Value Board, with the PMRI approach, helped students develop the concept of place value for whole numbers. Previous research demonstrates the novelty of the research, particularly the use of media within the PMRI approach. Therefore, the purpose of this study is to describe student activities during a realistic learning process, using the context of trailer tires and marble games, on the topic of addition and subtraction.

Method

This study uses the design research method presented by Gravemeijer & Cobb, type of research method that aims to advance theories concerning stages and learning tools that support learning (Indartiningsih et al., 2024). The subjects of this study were 23 first-grade students of SD Negeri 3 Krasak in Jepara Regency, Central Java. Data collection techniques used observation, field notes, and documentation. Then analyzed through 3 stages, namely (1) Preliminary design or preparing for the experiment is the stage where researchers compileHypothetical Learning Trajectory(HLT) that can be used in the next stage. HLT is a breakdown of learning objectives, activities and their descriptions, as well as estimates of students' ways of thinking so that they can develop to understand the activities carried out. (2) Teaching experiment is the stage of testing the HLT that has been made to students. So that things that are anticipated are in accordance with the reality that occurs or not. (3) Retrospective analysis is the stage used to answer research questions and create research conclusions.

Result and Discussion

This study consists of several stages, namely preliminary design, teaching experiment, and retrospective analysis. Preliminary design is the stage where researchers design a HLT for mathematics lessons on addition and subtraction. HLT is then tested in the teaching experiment stage. This article focuses more on the teaching experiment and retrospective analysis stages in mathematics lessons covering addition and subtraction of numbers. Learning in addition and subtraction lessons

uses the PMRI approach, utilizing concrete media for addition lessons using truck tires and for subtraction lessons using marbles.

1. Preparing for the experiment

During the preparation stage, researchers developed a HLT for addition and subtraction. This HLT served as a guide for the learning process and a reference for anticipating potential student strategies.

a. HLT

The HLT on the material of adding numbers created in this study uses three learning activities, namely observing, drawing, and combining the wheels from the two boxes.

Tabel 1. *Hypothenical Learning Trajectory* penjumlahan

Activity	Objective	Activity Description	Conjecture
Let's Observe	Understanding addition is combining.	The teacher provides illustrations in the form of pictures or toy trucks. Then, the teacher instructs the students to count the number of tires on the front and rear of the truck.	Students can count the number of tires on the front and rear of the truck.
Let's Draw	Students can count the number of wheels on the front and rear of the trailer truck.	The teacher instructs students to draw the wheels on the front and rear of the trailer in separate boxes. Students can then count the number of wheels on both boxes.	Students can count the number of wheels on each box of the truck.
Let's combine the wheels from both boxes	Students can understand the meaning of combination in addition.	The teacher instructs students to count the total number of wheels in both boxes. For example, there are 4 wheels on the first box and 4 wheels on the second box. Therefore, 4 + 4 = 8 wheels on the trailer truck.	Students can understand that addition is combining.

Meanwhile, the HLT on the material of subtraction of numbers created in this study uses three learning activities, namely playing, drawing, and carrying out subtraction operations by eliminating.

Tabel 2. *Hypothenical Learning Trajectory*Pengurangan

Activity	Objective	Activity Description	Conjecture
Let's Play	Understanding subtraction is removing The teacher invites students to practice playing marbles.	The teacher makes a circle and fills it with several marbles. Then, students are asked to aim at the marbles in the circle.	Students are able to analyze subtraction problems in everyday life.

Let's Draw	Students can count the number of marbles inside the circle and the marbles that are outside the circle in the marble game.	Students draw the number of marbles that are still inside the circle and draw the number of marbles that are outside the circle.	Students are able to distinguish between the number of marbles before playing the circle marble game and the number of marbles after playing the circle marble game.
Let's combine the wheels from both boxes	Students are able to understand the meaning of removal in subtraction.	The teacher gives instructions to the students by drawing all the marbles inside the circle before playing the circle marble game in parallel. Then, after practicing by aiming at the marbles, students can remove the number of marbles outside the circle. For example: initially there are 15 marbles in the circle, and after aiming, 6 marbles are removed. Therefore, 15 - 6 = 9.	Students can understand that subtraction involves removing.

2. Teaching Experiment

a. In the process of adding

The teaching experiment was conducted in class 1 of SD Negeri 3 Krasak Jepara with 23 students. The first activity began with greetings and prayers, followed by an introduction that the lesson would involve working on exercises together.

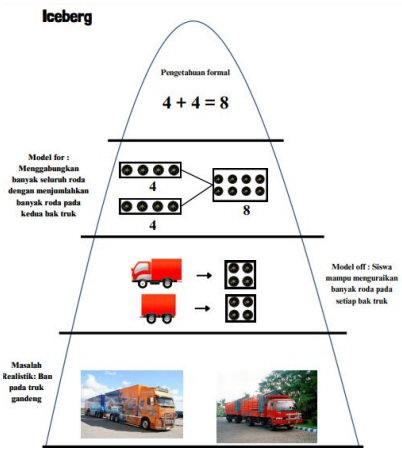

Figure 1. *Ice berg* Addition

In the apperception activity, the teacher used the context of a trailer truck to introduce addition. Students responded enthusiastically and were able to relate it to everyday experiences. One student stated, "There are 4 front wheels and 4 rear wheels, so 4 plus 4 equals 8" (student R). This quote demonstrates that students understand addition as a combination process.

The activity of drawing wheels on two boxes, then combining them, helped students transition from concrete media to visual representations. In individual problems, students were able to apply this strategy in the form of simple mathematical operations. Thus, the results indicate that the HLT designed is appropriate for students' thinking development and facilitates understanding of the concept of addition through real-world contexts.

b. In the Reduction Process

After learning addition, students were given a new activity, which was subtraction based on a marble game.

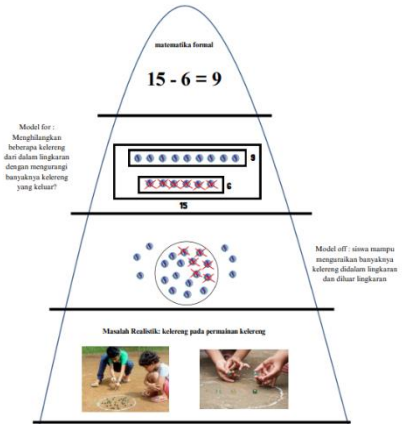

Figure 2.*Ice berg* Reduction

The concept of subtraction is introduced through a game of marbles. Students initially count 15 marbles, then after shooting, four marbles are removed, leaving 11. One student states, "Initially there were 15, but four were removed, leaving 11." This demonstrates that students understand subtraction as the process of subtracting or taking away a portion from a whole. In the next stage, students draw 15 marbles and then cross out four marbles to get the remainder, 11. This activity facilitates the transition from concrete objects to images transfused into mathematical symbols, enabling students to write the mathematical sentence 15 – 4 = 11.

3. Result *Retrospective Analysis*

The results of a retrospective analysis indicate that learning using real-world contexts can help students understand addition and subtraction. For addition, the trailer truck provided a meaningful learning experience through activities such as observing, drawing, and combining the number of wheels. Students enthusiastically counted the number of wheels on two trailer trucks, then represented them through drawings, and finally matched their observations with the calculated results. This process confirmed that students understood addition as combining two groups of numbers.

For subtraction, researchers used a traditional marble game to foster learning motivation. Students

counted the number of marbles in a circle and then observed the change in the number after some of the marbles were removed. This activity continued with drawing and expressing it in simple mathematical sentences, for example, 15 – 4 = 11. These results indicate that students were able to understand subtraction as the process of removing part from a whole.

Overall, the use of concrete media such as the trailer truck and the marble game was proven to increase students' engagement, curiosity, and conceptual understanding. These findings confirm that learning based on real-world contexts can strengthen the construction of mathematical understanding, where addition is interpreted as combining and subtraction is interpreted as removing.

Discussion

Based on research findings, realistic mathematics learning using the context of trailer truck tires and a game of marbles proved effective in developing students' understanding of addition and subtraction. The learning process, which progresses through concrete-visual-symbolic stages, allows for gradual knowledge construction. In the trailer truck tire context, students were invited to observe the number of wheels, draw a picture, and then write it in the form of a mathematical sentence. This activity demonstrated that students understood addition as the process of combining two groups of numbers. Meanwhile, through the game of marbles, students observed the change in the number after some marbles were removed, drew a picture with a cross, and then wrote the mathematical sentence 15 – 4 = 11. This demonstrates that students understand subtraction as the process of subtracting or taking a part from a whole.

Direct student involvement in real-world activities is crucial for building conceptual meaning. In line with the findings of Juniansyah & Saputri(2024)the use of concrete media can enhance learning activities, teacher-student interaction, and conceptual understanding in mathematics. Similarly, research by Alim et al.(2024)confirmed that the Realistic Mathematics Education (RME) approach significantly improved the motivation and learning outcomes of elementary school students. Thus, these research findings are consistent with previous findings that concrete media act as a bridge between students' real-life experiences and mathematical abstractions.

Furthermore, these research findings reinforce the theoretical framework of RME, which emphasizes the importance of the mathematization process, namely the transformation of real situations into mathematical objects. In the learning process, the activity of drawing a truck tire or a marble represents a form of "model of" that then develops into a "model for" Dinarti & Qomariyah(2022)where students begin to generalize their understanding to solve new problems. This principle aligns with recent research by Tantri et al.(2024)which asserts that the success of RME lies in students' ability to construct representations from concrete experiences to mathematical symbols.

Furthermore, students' physical involvement in the marble game can be understood from an

embodied cognition perspective, where mathematical understanding is constructed through meaningful bodily activity. A recent study by Wathoni(2024)showed that physical activity and the use of manipulatives can improve the retention of mathematical concepts because students more easily associate symbols with concrete experiences they have had. Thus, the use of truck tires and marbles as media is not only contextually relevant but also strengthens students' cognitive processes in understanding number operations.

The implication of these findings is the importance of teachers designing a learning trajectory that begins with a concrete context, then moves to visual representations, and finally to formal symbols. This process not only facilitates procedural understanding but also builds deep conceptual understanding. This aligns with the findings of Purwoko(2025)that real-world context-based learning strengthens the connection between students' everyday experiences and abstract mathematical concepts. Therefore, this study contributes to mathematics learning practices in elementary schools, particularly by demonstrating that the use of cultural contexts and traditional games can be an effective strategy in strengthening understanding of basic arithmetic concepts.

Conclusion

Based on research findings, realistic mathematics learning using the context of trailer tires and marbles has proven effective in improving elementary school students' understanding of the concepts of addition and subtraction. Through concrete-visual-symbolic stages, students can develop an understanding that addition is meaningful as a process of combining and subtraction is meaningful as a process of subtracting from a whole. The use of concrete media not only increases student engagement and motivation but also strengthens the mathematization process, which is the transformation of real experiences into mathematical representations. These findings confirm that the Realistic Mathematics Education (RME) approach is relevant for learning basic arithmetic operations, particularly by utilizing cultural contexts and traditional games close to students' lives. Consequently, teachers need to design learning trajectories that move from real experiences to abstract representations to deepen and deepen students' conceptual understanding.

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