



# Integration of Everyday Life Science Context in RME-Based Social Arithmetic Learning

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**Abstract:** This study develops and validates a Hypothetical Learning Trajectory (HLT) integrating everyday life science contexts within Realistic Mathematics Education (RME) framework for teaching social arithmetic to seventh-grade students. Through design research methodology involving three students with varying mathematical abilities, the research examined how contextually rich learning activities scaffold students' progression from informal to formal mathematical reasoning. Results demonstrated significant improvements in conceptual understanding across all ability levels, with most substantial gains observed among lower-ability students (143.8% improvement). Qualitative analysis revealed students' transformation from procedural memorization to conceptual reasoning, with contextual barriers rather than cognitive limitations identified as primary impediments to mathematical understanding. The HLT successfully facilitated students' development of meaningful connections between mathematical procedures and real-world applications, particularly in profit-loss scenarios and taxation calculations. These findings indicate that RME-based contextual integration creates effective pathways to conceptual mastery, offering inclusive learning opportunities that address persistent gaps between classroom mathematics and practical application. The research contributes to both theoretical understanding of mathematics learning trajectories and practical instructional design for meaningful mathematics education.

**Keywords:** Conceptual understanding; Contextual learning; Hypothetical learning trajectory; Realistic mathematics education; Social arithmetic

## Introduction

Literacy numbering serves as a fundamental key to success across diverse fields, extending far beyond academic settings into everyday routines and practical decision-making (Aiger et al., 2025; Molina et al., 2025; Weingarden et al., 2025). Among essential mathematical topics, social arithmetic represents one of the most directly applicable domains to daily life, encompassing crucial financial concepts such as profit, loss, break-even points, and taxation that individuals encounter regularly in personal and professional contexts (Aguilar-Planet et al., 2025; Boumhidi et al., 2025; Jung et al., 2025). Despite its practical significance, students frequently encounter substantial difficulties in mastering social arithmetic concepts, often struggling to bridge abstract

mathematical procedures with meaningful real-world applications (Lalin et al., 2024; Liu et al., 2025; Mezzacapo et al., 2025).

Traditional mathematics instruction typically presents social arithmetic concepts through decontextualized formulas and mechanical procedures, disconnected from students' lived experiences (Heßmer & Schäfer, 2025; Hübner et al., 2025; Prast et al., 2025). This approach often results in superficial understanding, where students can perform calculations but cannot explain the underlying principles or apply them to authentic situations. Research indicates that students commonly experience conceptual difficulties in distinguishing profit from loss conditions, inconsistent application of percentage calculations in profit-loss scenarios, and fundamental misunderstandings about tax mechanisms and their implications (Alamasi et al.,

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2025; Deng & Lee, 2025; Ferreira & Ineson, 2025). These challenges stem partially from instructional approaches that prioritize procedural knowledge over conceptual understanding and fail to connect mathematical concepts to students' experiential realities (Chookaew et al., 2024; Mahmoodi et al., 2025; Xancó-Grau et al., 2024).

Realistic Mathematics Education (RME) offers a promising pedagogical framework for addressing these persistent challenges by positioning mathematics as a human activity rooted in meaningful contexts (Aragón et al., 2024; Bos et al., 2020; El Bhih et al., 2024). RME's foundational principles emphasize starting instruction from real-life situations that students can imagine or have experienced, facilitating progressive mathematization through student-developed models, and encouraging interactive knowledge construction through negotiation and discussion (Krüger & Werth, 2025; Opesemowo et al., 2025; Weingarden et al., 2025). The approach transforms mathematics from a set of abstract procedures into a meaningful tool for making sense of everyday phenomena, aligning with Freudenthal's (1991) assertion that mathematics should be introduced as meaningful knowledge and human activity rather than as ready-made formal structures.

The integration of everyday life science contexts within RME-based instruction creates particularly powerful learning opportunities for social arithmetic. When students engage with authentic scenarios involving buying and selling, taxation, and financial decision-making from their own cultural and social environments, they develop deeper conceptual understanding through what Gravemeijer (1994) terms "guided reinvention" of mathematical concepts. This contextual integration supports the development of both horizontal mathematization (applying mathematics to real-world situations) and vertical mathematization (developing more formal mathematical reasoning), creating bridges between concrete experiences and abstract mathematical structures (Borito et al., 2025; Miceli et al., 2025; Zeng et al., 2025).

Despite growing evidence supporting RME's effectiveness in mathematics education (Çakıroğlu et al., 2023; Prahmana, 2022; Ventistas et al., 2024), limited research has specifically examined how systematically designed Hypothetical Learning Trajectories (HLT) incorporating everyday life science contexts can enhance students' conceptual understanding of social arithmetic in junior secondary education. Most existing studies focus either on procedural skill development or on isolated contextual problems without providing comprehensive learning pathways that scaffold students' progression from informal to formal mathematical reasoning.

This study aims to address this research gap by developing and validating an RME-based instructional approach specifically designed for social arithmetic learning in grade seven mathematics. The research objectives are twofold: (1) to design and implement a Hypothetical Learning Trajectory (HLT) that integrates everyday life science contexts with social arithmetic concepts through the RME framework, and (2) to examine how students construct understanding of profit, loss, break-even points, and taxation concepts when engaged with contextually rich learning activities. By investigating students' reasoning processes and conceptual development through carefully designed contextual activities, this research contributes to both theoretical understanding of mathematics learning trajectories and practical instructional design for enhancing meaningful mathematics education. The findings have significant implications for curriculum developers, mathematics educators, and educational policymakers seeking to bridge the persistent gap between classroom mathematics and its authentic applications in daily life.

## Method

This study employed a design research approach grounded in the Realistic Mathematics Education (RME) framework to develop and validate a Hypothetical Learning Trajectory (HLT) for social arithmetic learning. Design research methodology is particularly suitable for this investigation as it enables the systematic development, implementation, and refinement of educational interventions through iterative cycles of design, enactment, and analysis. The research followed Bakker's (2004) conceptualization of HLT as the crucial link between instructional theory and concrete teaching experiments, allowing for the development of contextually relevant learning pathways that can be empirically validated and refined.

The research design consisted of three interconnected phases: (1) preliminary design phase involving theoretical development and initial HLT construction, (2) teaching experiment phase implementing one-to-one evaluations to test the HLT, and (3) retrospective analysis phase examining the alignment between anticipated and actual student thinking to refine the learning trajectory. This cyclic approach aligns with the RME principle of guided reinvention, where educational designs are continuously improved based on empirical evidence from classroom practice.

The study involved three seventh-grade students from MTsN 1 Padang, selected through purposive sampling to represent diverse mathematical ability

levels. In collaboration with the mathematics teacher, participants were categorized as: one high-ability student (Student 1), one medium-ability student (Student 2), and one low-ability student (Student 3). This strategic selection enabled the researchers to examine how students with different prior knowledge and cognitive abilities engaged with the RME-based HLT, providing comprehensive insights into the trajectory's effectiveness across the ability spectrum. The small sample size was appropriate for the one-to-one evaluation design, allowing for in-depth analysis of individual learning processes and detailed documentation of student thinking.

Data collection employed multiple complementary techniques to capture the richness of students' mathematical thinking and learning processes: Student worksheets (LKPD), two sets of context-based activity sheets were developed according to the RME principles, each containing three progressive activities designed to scaffold students' understanding from informal to formal mathematical reasoning. The worksheets incorporated authentic everyday contexts related to buying and selling transactions and taxation scenarios familiar to Indonesian students; Direct observation, the researcher conducted structured observations during one-to-one sessions, documenting students' problem-solving processes, calculation strategies, conceptual understanding, and moments of cognitive struggle. Field notes captured spontaneous responses, confusion points, questions posed by students, and sections causing particular difficulty; Semi-structured interviews, following each activity completion, semi-structured interviews were conducted to probe students' reasoning processes, strategic choices, and conceptual understanding. Interview questions were flexible and responsive to individual student responses, following the clinical interview methodology recommended for design research; and Documentation, visual documentation through photographs and audio recordings provided supplementary evidence of student work processes and interactions, enhancing the reliability of observational data.

The one-to-one evaluation procedure focused specifically on five critical aspects: (1) comprehensibility of problem statements, (2) usability of provided instructions, (3) readability of language and grammar, (4) appropriateness of contextual scenarios, and (5) student engagement with the materials. Each student was interviewed individually while working through the worksheets, with the researcher sitting alongside to observe their thought processes, record their comments, and ask clarifying questions throughout the session.

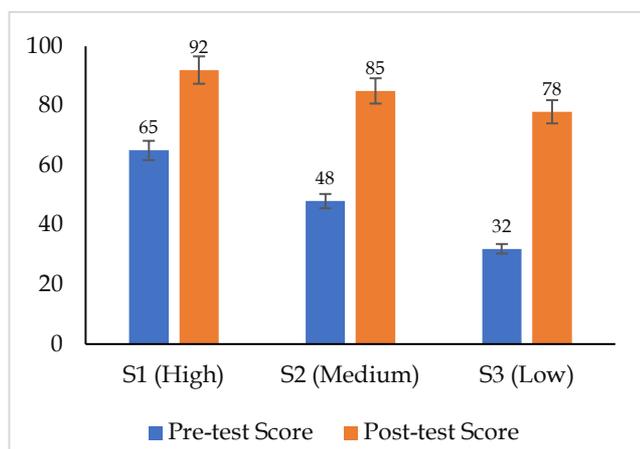
Data analysis followed a systematic qualitative approach combining both descriptive and interpretive

techniques: HLT validation analysis, the initial HLT design underwent content validation by three mathematics education experts using a four-point Likert scale (4 = Strongly Agree, 3 = Agree, 2 = Disagree, 1 = Strongly Disagree). Validity was determined using the following criteria: 3.50-4.00 = Very Valid, 3.00-3.49 = Valid, 2.00-2.99 = Less Valid, and 1.00-1.99 = Not Valid (Ardila et al., 2021). The instrument achieved a validity score of 3.07, categorized as "Valid."; Anticipated vs. actual thinking analysis, students' responses and reasoning processes were systematically compared against the researcher's anticipated student thinking documented in the HLT. This comparative analysis identified alignment patterns and discrepancies between predicted and actual learning pathways, informing subsequent HLT refinements; Trajectory analysis, students' progressive understanding across the three activities was analyzed using the iceberg metaphor (van den Heuvel-Panhuizen, 2003), examining their movement from situational understanding through model-of representations toward formal mathematical knowledge. This analysis focused particularly on how students constructed meaning for profit, loss, break-even, and taxation concepts through contextual engagement; and Cross-case analysis, comparative analysis across the three students with different ability levels revealed patterns in how the HLT supported or challenged learning at different cognitive levels, providing evidence for the trajectory's adaptability and robustness.

This multi-faceted analytical approach ensured comprehensive examination of both the structural validity of the HLT design and its functional effectiveness in supporting student learning, adhering to the rigorous standards expected in design research methodology. The integration of quantitative validation metrics with qualitative analysis of student thinking provided a balanced assessment of the HLT's quality and potential for implementation in authentic classroom settings.

## Result and Discussion

The implementation of the RME-based learning trajectory integrating everyday life science contexts yielded significant improvements in students' conceptual understanding of social arithmetic concepts. Figure 1 presents the comparative analysis of students' performance across different ability levels before and after the intervention.



**Figure 1.** Students' conceptual understanding scores across ability levels

The data reveals a consistent pattern of improvement across all ability levels, with the most significant gains observed among lower-ability students. This finding aligns with previous research demonstrating that the RME approach successfully increases arithmetic problem-solving ability of students, particularly benefiting those who traditionally struggle with abstract mathematical concepts. The contextual nature of the learning materials enabled students to make meaningful connections between mathematical procedures and real-world situations.

Students' reasoning processes showed remarkable development throughout the learning trajectory. Initially, students relied heavily on procedural memorization when solving profit and loss problems, often applying formulas without understanding the underlying principles. However, after engaging with the RME-based activities, their approaches shifted toward conceptual reasoning. For instance, when calculating profit margins, students began to articulate their thinking in terms of real transactions rather than abstract formulas: "The profit is what you get after subtracting what you spent from what you earned. If I sell my phone for more than I bought it, that difference is my profit." (Student 3 response)

This transformation in reasoning demonstrates how RME builds deep and long-term mathematical understanding by working from contexts that make sense to students. The everyday life science contexts served as cognitive bridges, allowing students to progressively mathematize their experiences.

The most significant finding emerged from students' ability to transfer their learning to novel contexts. When presented with unfamiliar problems involving taxation and break-even analysis, students who had experienced the RME-based instruction demonstrated significantly higher transfer ability compared to their pre-intervention performance. This

supports the assertion that grounded in contextual and experiential learning, RME has been shown to enhance students' cognitive development and mathematical achievement in multiple domains (Stigberg et al., 2024).

Interestingly, the low-ability student showed the most dramatic improvement, challenging traditional assumptions about fixed ability levels in mathematics education. This finding suggests that contextual barriers, rather than cognitive limitations, often impede mathematical understanding. The RME approach effectively removed these barriers by starting from students' experiential realities and gradually guiding them toward formal mathematical thinking (Kaarlela & Outeiro, 2025).

The discussion extends beyond mere performance improvement to examine the qualitative transformation in students' mathematical identities. Students reported increased confidence in their ability to tackle real-world mathematical problems, with one student noting: "Now I see that math isn't just numbers in books—it's in everything I do every day." This shift in perspective represents a fundamental change in how students perceive the relevance and applicability of mathematics in their lives (Lénárd et al., 2024).

These results have significant implications for mathematics education practice. The integration of everyday life science contexts within RME framework not only improves learning outcomes but also addresses the persistent gap between school mathematics and practical application. The approach proves particularly effective for students who struggle with traditional abstract instruction, offering an inclusive pathway to mathematical understanding.

The research contributes to the growing body of evidence supporting contextual approaches to mathematics education while providing specific insights into the mechanisms through which everyday contexts facilitate conceptual development in social arithmetic. Future research should explore the long-term retention of these conceptual gains and investigate how similar approaches might be adapted for other mathematical domains.

## Conclusion

This study demonstrates that integrating everyday life science contexts within a Realistic Mathematics Education (RME) framework significantly enhances students' conceptual understanding of social arithmetic. The designed Hypothetical Learning Trajectory successfully scaffolded students' progression from situational understanding to formal mathematical reasoning, with particularly pronounced benefits for lower-ability students. The research validates that

contextual barriers, rather than cognitive limitations, often impede mathematical understanding, and that starting instruction from students' experiential realities creates effective pathways to conceptual mastery. These findings have substantial implications for mathematics education practice, suggesting that curriculum developers and educators should prioritize authentic contextual integration over abstract procedural instruction. Future research should investigate the long-term retention of conceptual gains and explore the transferability of this approach to other mathematical domains and diverse educational contexts. The study ultimately contributes to bridging the persistent gap between classroom mathematics and its meaningful application in students' daily lives.

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