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Market simulation as a vehicle for peer-mediated whole-number construction in grade 2

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Abstract

This study explores how Grade 2 students construct the concept of whole numbers through a market simulation at SDN Citra Indah Sukamaju. The research was driven by students' difficulties in understanding the abstract nature of place value. Using a qualitative descriptive design, data were collected through a preliminary cognitive diagnostic assessment, participatory observations, project rubrics, and student feedback. The results demonstrate that the market simulation created an authentic learning environment characterized by active student engagement in contextual problem-solving without teacher dominance, thereby fostering intensive social interaction. Based on the initial diagnostic assessment, 12 students (33.3%) who successfully answered higher-order thinking skills (HOTS) questions were identified as More Knowledgeable Others (MKOs) and provided essential peer scaffolding. Consequently, 24 students (66.7%) within the Zone of Proximal Development (ZPD) engaged in collaborative negotiations and showed measurable improvements in conceptual understanding through task completion. These findings suggest that the simulation provides an interactive pathway to support peer scaffolding and strengthen students' conceptual understanding of whole numbers, rather than serving as a means of tracking formal developmental shifts.

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INTRODUCTION

Elementary education, particularly at the lower levels such as second grade, constitutes a vital transitional phase in which students are positioned within the concrete operational stage. During this phase, the introduction of mathematical concepts, including whole numbers, must be contextualized through real-life experiences rather than presented abstractly, thereby fostering meaningful learning.

This perspective is supported by Fadila and Syutaridho (2025) and Ashkenazi and Hasson (2026), who asserted that students in the lower grades need to effectively integrate mathematical symbols within social contexts to attain a comprehensive understanding. Consistent with this view, Mahmudah and Ratnasari (2025) and Moremi and Sekao (2025) emphasized that mastery of whole-number concepts enhances students' capacity for mathematical and systematic thinking.

However, a significant gap persists between these theoretical ideals and the instructional reality at SDN Citra Indah Sukamaju. Preliminary classroom observations conducted over two weeks revealed a profound lack of peer-to-peer discourse, with students showing strong dependence on teacher-centered instruction. This passivity reflects a broader challenge identified by Sidik et al. (2021) regarding learning obstacles in whole-number operations for problem-solving. Furthermore, a preliminary cognitive diagnostic assessment conducted prior to the intervention provided empirical evidence of this gap. Of the 36 students, 24 students (66.7%) struggled to internalize place value and failed to solve basic Higher-Order Thinking Skills (HOTS) questions, relying instead on rote memorization. This condition stands in stark contrast to the 4C skills, namely critical thinking, creativity, communication, and collaboration, required in 21st-century education (Nurhayati et al., 2024; Realitawati et al., 2024). Without active engagement, students are less able to strengthen the dimensions of the Pancasila Student Profile, particularly personal resilience and collaboration (Rusnaini et al., 2021).

To address this gap, a market simulation was selected as a strategic intervention to foster a social constructivist learning environment. According to Do et al. (2023) and Setiyaningsih and Subrata (2023), students must become active participants who autonomously develop their understanding through the Vygotskyan constructivist paradigm. This approach is further strengthened by the application of role-playing models, which, according to Juliana Sari et al. (2024) and Wijayanto et al. (2025), are more effective than conventional models in promoting student collaboration and understanding of norms. The use of the Zone of Proximal Development (ZPD) through market simulation enables the presence of More Knowledgeable Others (MKOs) who support peer scaffolding during learning. This strategy also aligns with the use of interactive, culture-based media to bridge conceptual gaps (Nuha & Sundi, 2025; Yulia Safitri & Jupriyanto, 2025).

The theoretical framework of this study integrates Piaget's structural stages with Vygotsky's social constructivism to map the process of mathematical conceptualization. Within this model, the market simulation functions as an authentic social environment tailored to students in the concrete operational stage, where abstract mathematical symbols are transformed into tangible entities. Within this environment, peer interaction triggers learning within the Zone of Proximal Development (ZPD). Specifically, students acting as More Knowledgeable Others (MKOs) provide spontaneous verbal and behavioral scaffolding during transactions. This collaborative negotiation discourse serves as the primary mechanism that enables peers to

internalize the concept of whole numbers, thereby bridging the gap between passive memorization and active conceptual construction.

While prior studies have independently examined market simulations for elementary skills (Nuha & Sundi, 2025) and whole-number concepts (Mahmudah & Ratnasari, 2025; Sidik et al., 2021), this study extends the literature by capturing the micro-level negotiation discourse among Grade 2 students. Specifically, it investigates how spontaneous mathematical talk during transactions serves as a functional vehicle for peer scaffolding, a dimension often overlooked in broader pedagogical evaluations. This study aims to explore how communication and negotiation discourse within a market simulation facilitate collective understanding, providing an interactive pathway to support and scaffold peers' conceptual understanding of whole numbers rather than tracking formal developmental shifts.

METHOD

This study employed a qualitative descriptive research design. Its objective was to provide a comprehensive exploration and description of students' collaborative skills and the construction of whole-number concepts within a social constructivist framework. In this paradigm, the researcher served as the primary instrument for observing and analyzing real-time interactions within the Zone of Proximal Development (ZPD) and the role of More Knowledgeable Others (MKOs).

The study involved 36 second-grade students at SDN Citra Indah Sukamaju. The participants were selected using purposive sampling to ensure heterogeneous ability levels within each group. This selection was essential for encouraging peer-to-peer scaffolding, allowing students with higher actual abilities, as potential MKOs, to assist peers within their ZPD in solving collective mathematical challenges.

The intervention utilized a market simulation as an authentic learning prototype. This method transformed abstract numerical symbols into functional tools for social interaction. The research procedures were divided into three systematic phases: preparation, interaction, and reflective construction. In the preparation phase, students were assigned roles and provided with numerical media. In the interaction phase, students engaged in transactions that required the application of place-value concepts. In the reflective construction phase, a post-simulation session was conducted to validate students' conceptual understanding.

The research procedures were implemented through a structured three-phase model comprising preparation, interaction, and reflection to map the micro-level negotiation discourse during whole-number construction. The detailed chronological steps and decision-making points of this qualitative design are illustrated in Figure 1.

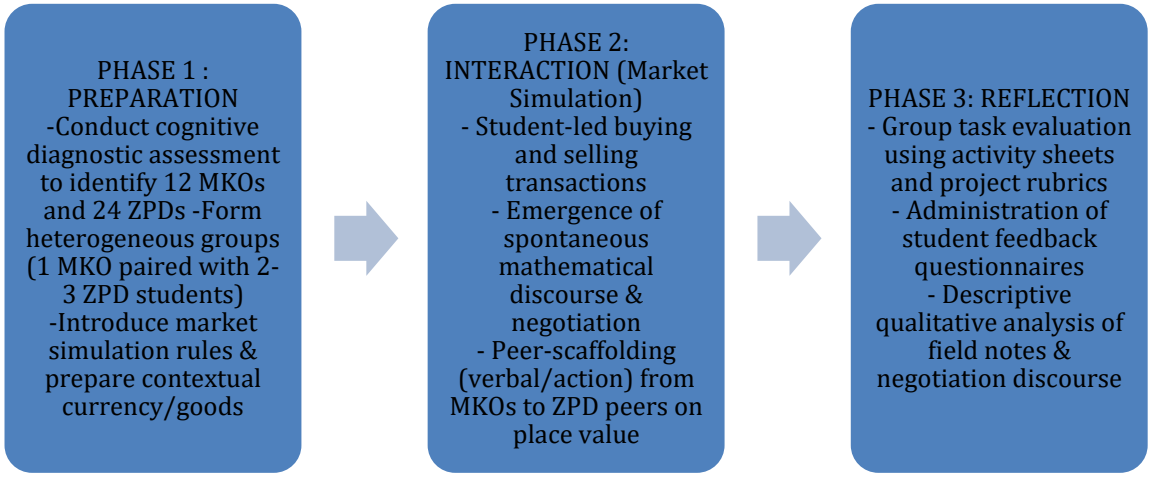

Figure 1. Research Procedure Flowchart of Market Simulation

To ensure comprehensive data triangulation, four main instruments were employed: (1) a participatory observation rubric to record communication patterns and scaffolding; (2) project sheets to measure the accuracy of concept construction during transactions; (3) student response sheets to gather reflective data and identify MKOs from the students' perspectives; and (4) documentation, including photos and videos, to capture nuanced social cues.

Data were analyzed using the Miles and Huberman framework, which consists of data condensation, data display through narrative descriptions, and conclusion drawing. To ensure the rigor and consistency of the findings, this study employed technique triangulation by cross-referencing field observations, student project artifacts, and reflective feedback. This process was conducted to strengthen the credibility of the research findings (Sugiyono, 2019; Moleong, 2017).

RESULT AND DISCUSSION

Result

The implementation of the market simulation significantly altered the classroom environment at SDN Citra Indah Sukamaju. Based on participatory observation, students showed high enthusiasm for fulfilling their roles as buyers and sellers. The interaction shifted from teacher-led to student-centered, with peer-to-peer communication becoming the primary mode of learning. Quantitative tracking showed that 12 students (33.3%) consistently demonstrated the ability to lead their peers, while 24 students (66.7%) actively sought guidance during transactions. The detailed distribution of these developmental levels and their respective roles in the simulation is summarized in Table 1. To address the operational distinctions between these roles, the table further delineates their specific group configurations, behavioral indicators, role stability, and the empirical success rates achieved during the collaboration.

Table 1. Operational Framework and Distribution of Student Roles

Student Role	Operational Definition	Distribution per Group	Key Practical Indicator	Role Stability	ZPD Success Rate
More Knowledgeable Other (MKO) (n=12)	Students who mastered HOTS diagnostic questions and autonomously guide calculations.	2 MKO student per learning group.	Spontaneously provides verbal instructions and corrects peer errors during transactions.	Stable (100% remained as mentors throughout all phases).	N/A
Zone of Proximal Development (ZPD) (n=24)	Students requiring assistance to internalize place value.	4 ZPD students per learning group.	Completes market transactions using tangible media after receiving peer scaffolding.	Stable (Remained as active recipients of scaffolding).	91.6% (22 out of 24 completed all transaction tasks).

Data from the field notes provided concrete evidence of how scaffolding occurred during the simulation. In one recorded instance, an MKO student guided a peer who was confused about the value of money. The MKO instructed, “Do not give back ten thousand rupiah right away. First, calculate the price as 150. The money is two hundred, so the change is only fifty.” This interaction led to a clear conceptual breakthrough from the peer, who responded, “Oh, so the remaining change is fifty? I will try to count my money again.” Regarding conceptual construction, one student successfully identified the positional value of digits by stating, “Oh, so the number one in front of one hundred fifty means one hundred coins, right, Ma’am?”

In addition to cognitive mastery, students’ engagement and perceptions of the market simulation were measured through a response questionnaire. The results, summarized in Table 2, reflect a high level of acceptance, with a significant majority of students expressing positive responses toward the collaborative learning model.

Table 2. Summary of Student Responses to Collaborative Learning

Response Indicator	Strongly Agree	Agree	Disagree
Pleased to learn through market simulations	28 (77.8%)	8 (22.2%)	0 (0%)
Confident in expressing opinions during the simulation	24 (66.7%)	10 (27.8%)	2 (5.5%)

Feeling confident when working in a group	20 (55.6%)	14 (38.9%)	2 (5.5%)
Average Positive Response	66.7%	29.6%	3.7%

As detailed in Table 2, the descriptive analysis of the student response questionnaire indicates an overwhelmingly positive reception of the market simulation. The highest level of consensus was observed in students' enthusiasm, with 28 students (77.8%) strongly agreeing that they were pleased to learn through this method. Furthermore, the collaborative aspect fostered both emotional and academic confidence, as 66.7% of the participants strongly agreed that they felt secure expressing their opinions during the transactions. Conversely, only a small proportion of the class, 5.5%, expressed disagreement regarding their confidence in group settings. This overall positive trend is reinforced by the average positive response rates, which reached 66.7% for "Strongly Agree" and 29.6% for "Agree," indicating that the intervention was well received by the second-grade students.

Discussion

The results clearly indicate that social mediation within the Zone of Proximal Development (ZPD) is a viable solution for mitigating the issue of teacher dependency identified in the preliminary study. As observed in the interactions between MKOs and their peers, the market simulation shifted the locus of knowledge authority from the teacher to the student collective. This dialogue demonstrates that learning is a social process in which abstract concepts become functional necessities, confirming Vygotsky's (1978) theory that cognitive functions originate in social relationships. This finding aligns with Dogbey (2025), who emphasized that fostering rich classroom discourse and supporting students' invented strategies are crucial for deepening mathematical instruction. Specifically, the negotiation discourse observed in this study served as a cognitive scaffolding mechanism through which students continuously re-evaluated their mathematical assumptions. When students engaged in bargaining, they were not merely practicing communication; they were actively quantifying value, comparing magnitudes, and transforming abstract numerical symbols into concrete assets. This iterative verbalization within peer groups encouraged deeper cognitive processing of whole numbers, moving students beyond passive reception toward active internal construction.

The findings of this study reinforce the arguments of Prayogi and Puspita (2025), who found that constructivism-based models significantly increase student participation, reaching 83%, and strengthen conceptual understanding. However, the empirical data also reveal a critical boundary of this peer-mediated framework, as evidenced by the 91.6% success rate, although two ZPD students, equivalent to 8.4%, failed to complete the transaction task, as shown in Table 1. This marginal non-success aligns with the feedback presented in Table 2, indicating that 5.5% of students experienced persistent anxiety and lacked confidence during group interactions. This

finding explicitly suggests that although peer-led scaffolding significantly reduces cognitive barriers, its pedagogical effectiveness remains constrained by individual communicative readiness and social anxiety among lower-grade students.

Furthermore, this research expands on the work of Nuha and Sundi (2025) regarding simulations in elementary education. Focused on broader socio-economic engagement, the present study provides a more specialized focus on negotiation discourse as a specific catalyst for mathematical construction. This comparison highlights that although simulations can improve social skills, their primary strength in this context lies in bridging the gap between mathematical symbols and functional reality. In response to the challenge of rote memorization, the case in which a student linked the digit "1" to "one hundred coins" provides a qualitative illustration of how authentic experiences can support students in the concrete operational stage. Although this single case suggests a potential shift from abstract symbols to tangible market media, the authors acknowledge that this finding represents an isolated observation within the cohort rather than a systematic change across all participants.

Nevertheless, from a theoretical standpoint, this micro-context underscores the critical role of cognitive conflict and its resolution in realistic mathematics education. It suggests that even brief authentic experiences can disrupt deeply ingrained rote memorization habits. This implies that, for abstract mathematical symbols to have functional meaning for second-grade students, instructional design must consistently embed numbers within culturally and socially meaningful practices rather than treating them as isolated syntactic entities. Within this framework, the interactive nature of the market simulation provided an alternative pathway that encouraged students to contextualize numerical values while offering a supportive social environment to reduce the passivity typically observed in traditional teacher-centered instruction at SDN Citra Indah Sukamaju.

Finally, the high level of student acceptance detailed in Table 2 indicates that the authentic simulation has the potential to foster immediate indicators of 21st-century 4C skills, particularly communication and collaboration. When students co-construct mathematical meaning without teacher dominance, they organically demonstrate preliminary steps toward the core value of mutual cooperation, or *gotong royong*, as mandated by the Pancasila Student Profile. Consequently, these insights suggest localized pedagogical adaptations for early-grade mathematics instruction. Teachers should consider transitioning from being primary dispensers of mathematical rules to becoming designers of interactive social learning environments. Practically, this involves integrating micro-simulations and structured peer dialogue into daily lesson plans, ensuring that mathematical construction is treated as a collaborative and ongoing discourse rather than a series of solitary and abstract tasks.

CONCLUSION

This study demonstrates that the implementation of a market simulation supported the development of whole-number concepts at SDN Citra Indah Sukamaju.

The simulation served as a functional bridge that helped students move from abstract memorization toward a more concrete understanding. Peer-led scaffolding and tangible media showed potential in addressing the barriers of teacher dependency and rote memorization observed during the intervention. Although these findings are promising, they remain limited to a single classroom setting. Therefore, future researchers are encouraged to replicate this model across multiple schools and diverse mathematical content areas to examine its generalizability. Educators who intend to adopt this model should carefully consider students' readiness and the structured nature of peer scaffolding in early elementary mathematics to optimize its pedagogical benefits..

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