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Exploring Elementary Students' Mathematical Connection Ability Through Story Problem Solving: A Qualitative Insight Into Learning Challenges in Early Grade Classrooms

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ABSTRACT:
Background: Difficulties in early grade mathematics often arise when students are unable to recognize how mathematical ideas relate to one another or to situations expressed through language. These challenges become particularly visible when they encounter story problems, where they must interpret verbal information, construct meaning, and organize strategies based on conceptual connections rather than memorized procedures. Such learning difficulties point to the need for closer examination of how young learners form cognitive links within classroom interaction.
Aims: This study examines the mathematical connection ability of third-grade students by identifying how they relate concepts, representations, and contextual information while solving story problems.
Method: A qualitative descriptive approach was employed with six students selected to represent high, medium, and low levels of problem-solving proficiency. Data were collected through written tasks, classroom observations, and individual interviews, then analyzed using Miles and Huberman's framework to trace how students connected mathematical ideas across established indicators.
Results: Students with high problem-solving proficiency demonstrated the ability to coordinate multiple representations and recognize relationships among mathematical concepts. Those in the medium group formed only partial connections, while students in the low group consistently struggled to link verbal information with mathematical structures, indicating limited conceptual grounding.
Conclusion: The findings underscore the importance of instructional practices that encourage learners to articulate reasoning, negotiate meaning, and relate mathematical language to familiar contexts. Classrooms that rely heavily on memorization tend to restrict students' opportunities to develop deeper conceptual connections. Strengthening these connections requires deliberate teacher scaffolding, frequent exposure to contextual problems, and learning activities that invite students to build meaning through exploration and guided discourse. Such conditions are essential for reducing early learning difficulties and supporting more meaningful engagement with mathematics.
Keywords: Classroom learning; Mathematical connection; Problem-solving; Story problems; Student cognition.
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INTRODUCTION

Difficulties in elementary mathematics frequently emerge from students' limited ability to connect mathematical ideas with the verbal contexts in which those ideas are embedded. These challenges become particularly apparent when students encounter story problems that require interpretation, reasoning, and the integration of multiple concepts rather than simple procedural recall. Mathematical learning in the early grades therefore involves not only computational skills but also conceptual coherence that supports meaning-making. Previous studies indicate that many students fail to bridge everyday experiences with mathematical representations, resulting in fragmented understanding and inconsistent problem-solving performance (Anugraheni et al., 2025; Xie et al., 2021). Such early learning gaps are critical because they tend to persist across grade levels and influence students' long-term achievement and confidence in mathematics.

Research further suggests that young learners' mathematical reasoning is shaped by how they interpret language, build representational links, and negotiate meaning during classroom interaction. When solving story problems, students must coordinate textual information, numerical relationships, and contextual cues to construct meaningful solutions. Evidence from studies on visual representation and embodied learning shows that gestures, visual supports, and representational switching play a significant role in helping students organize and internalize mathematical ideas (Alibali et al., 2023). Other research highlights that strategic reasoning and engagement with rich problem contexts influence how learners integrate conceptual and contextual information, particularly in problem-solving environments (Chen et al., 2024; Seaburn, 2022). Studies in integrated and transdisciplinary learning further demonstrate that connections between mathematics and real-life situations require deliberate instructional support to develop effectively (Almarcha et al., 2023; Hardy et al., 2021).

The rationale for this study lies in the need to connect theoretical perspectives on mathematical cognition with practical insights from classroom learning experiences. Although previous research has explored conceptual linking, limited attention has been given to how young learners coordinate multiple forms of information when solving contextual tasks, particularly in authentic classroom settings. This gap is critical in early grade instruction, where story problems are commonly used but often reduced to procedural computation rather than meaning-making. By clarifying students' connection processes, this study offers theoretical and practical contributions that can inform instructional design, assessment practices, and pedagogical strategies aimed at fostering integrated and flexible mathematical understanding.

Research on mathematical connections increasingly highlights the importance of integrating representations, contexts, and discourse in developing students' conceptual understanding. Studies in realistic visual representation suggest that learners benefit from linking everyday experiences with symbolic mathematical structures, showing improved comprehension and reasoning (Weingarden et al., 2026). Complementary research in STEAM-based transdisciplinary learning indicates that problem contexts drawn from authentic scenarios strengthen students' ability to connect concepts across domains (Saimon et al., 2025). Visual-cognitive skills such as disembedding have also been shown to influence how students extract relevant information from complex tasks (Kus & Newcombe, 2025). Gesture-supported reasoning further enhances conceptual clarity, particularly in tasks involving multiplicative structures (Jouannet, 2025). Studies on strategic choice in problem-solving

environments reveal that learners' reasoning integrity is shaped by their capacity to coordinate conceptual and contextual cues (Russo & Russo, 2025). Other work shows that deliberate practice formats foster stronger internal connections among mathematical ideas when instructional design is informed by learning theories (Leuders & Loibl, 2025). Together, these findings underscore the significance of cognitive, representational, and contextual processes in shaping learners' mathematical connections.

A second body of literature provides further insight into how instructional design and learning environments influence students' ability to form mathematical connections. Research on mathematical modelling has identified key enablers, including conceptual coherence and representational flexibility, which support meaningful engagement with contextual problems (Geiger et al., 2025). Contextual curriculum design, such as problem-based learning frameworks, has been shown to enhance learners' conceptual integration through authentic problem-solving experiences (Edson et al., 2025). Cooperative learning environments that incorporate game-based tasks have demonstrated improvements in teamwork, reasoning quality, and conceptual connectedness (Yonwilad et al., 2025). Moreover, empirical work conducted in Indonesian elementary schools shows that realistic problem-based learning directly improves mathematical connection ability, reinforcing the importance of contextual instruction (Anugraheni et al., 2025). Additional studies in primary digital learning environments report that integrated tasks support incidental conceptual development, revealing how technology mediates connection-making processes (Ross et al., 2025). These findings collectively affirm that instructional conditions play a critical role in shaping students' capacity to relate mathematical concepts across situations. Nevertheless, limited research has focused specifically on how early grade learners construct these connections during story-problem solving. Addressing this gap requires close examination of students' reasoning in authentic classroom contexts.

Although numerous studies have examined mathematical understanding and problem solving, limited attention has been given to how elementary students integrate linguistic interpretation and mathematical representation when solving story problems. Existing research often focuses on older learners or experimental settings, leaving early grade classroom contexts underexplored. Moreover, differences in connection-making processes across varying levels of problem-solving proficiency remain insufficiently documented. This gap indicates the need for qualitative classroom-based studies that closely examine how young learners construct mathematical connections during authentic learning activities.

The purpose of this study is to investigate how third-grade students construct mathematical connections while solving story problems in real classroom contexts. Specifically, the study aims to explore differences in connection-making processes among students with high, medium, and low problem-solving proficiency. It also seeks to identify learning barriers that hinder students' ability to relate contextual information to mathematical representations. Through this analysis, the study intends to provide insights that support more effective instructional practices in early mathematics education.

METHOD

Research Design

This study employed a qualitative descriptive design to examine students' reasoning processes as they engaged with story problems in authentic classroom settings. This approach is suitable for

exploring how young learners construct conceptual links through interpretations, errors, and representational choices that are not easily captured by quantitative methods alone. The design reflects methodological perspectives that conceptualize learning as a meaning-making process embedded in classroom discourse, providing a strong basis for interpreting the development of mathematical connections and learning difficulties (Martin et al., 2021; Zhang, 2024).

Participants

Participants consisted of six third-grade students selected through purposive sampling to represent high, medium, and low levels of problem-solving proficiency. This sampling ensured that variations in conceptual linking could be examined across different learner profiles. The students were drawn from one public elementary school and remained within their regular classroom environment during data collection. Such contextual authenticity strengthens the ecological validity of the findings and supports alignment with JOLE's classroom-based research focus. Parental consent and school approval were obtained prior to participation.

Instruments

Three instruments were employed: a problem-solving test to categorize students, a mathematical connection test based on story problems, and a semi-structured interview protocol. The written tasks captured how students coordinated contextual information, representations, and mathematical structures, while interviews were used to clarify reasoning processes that were not evident in written responses. Observation notes complemented these instruments by documenting students' strategic behavior and classroom discourse, providing a comprehensive view of their conceptual connections across contexts.

Data Analysis Plan

Data analysis followed the Miles and Huberman interactive model, encompassing data reduction, data display, and conclusion drawing (Asipi et al., 2022; Sopian & Hidayatulloh, 2024). Students' written responses, interview transcripts, and observation notes were examined repeatedly to identify patterns in mathematical connection indicators, including language interpretation, representational linking, and contextual reasoning. The coded findings were then compared across ability groups to capture variations in conceptual integration and ensure that interpretations were consistently supported by multiple sources of evidence.

RESULTS AND DISCUSSION

Results

Overview of Students' Mathematical Connection Performance

Students showed distinct patterns across high, medium, and low problem-solving categories when working with story problems. High-performing students consistently connected contextual information with appropriate mathematical representations, while medium-performing students formed partial links and low-performing students misinterpreted linguistic cues, resulting in incorrect representations. These patterns indicate that students' mathematical connection ability depends strongly on their capacity to interpret context, coordinate reasoning, and translate meaning into symbolic form.

Table 1. Mean Scores of Mathematical Connection Indicators Across Two Meetings

Indicator	Meeting 1	Meeting 2	Mean
Representational relationships	2.81	2.89	2.85
Inter-topic connections	2.63	3.04	2.84
Real-life application	1.56	2.76	2.16
Equivalent representation	2.41	2.81	2.61
Procedural relationships	2.52	3.11	2.82
Cross-topic application	1.85	2.85	2.35

The table indicates that students achieved higher performance on indicators involving internal mathematical representations, while real-life and cross-disciplinary application remained comparatively weaker. Although scores increased across meetings, the continued gap in contextual application suggests deeper cognitive and linguistic challenges that require instructional scaffolding to bridge abstract mathematics and real-world meaning.

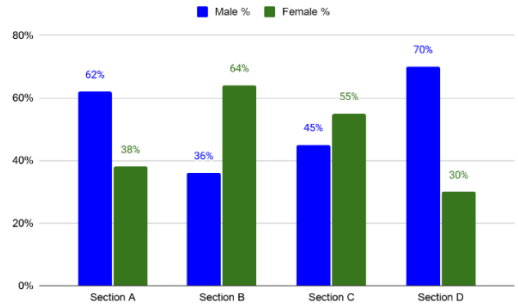

Figure 1. Sample Student Work (Correct Operation Using Integer Concepts)

The figure shows how a high-performing student accurately applied integer operations by aligning contextual information with appropriate mathematical representations. This work illustrates strong coherence between linguistic interpretation and symbolic expression, reflecting effective mathematical connection-making.

Figure 2. Sample Student Work (Misinterpretation of Operation)

This figure shows a low-performing student who used procedures that were mathematically correct in form but disconnected from the story context. The student misinterpreted the meaning of quantities, leading to inconsistent or irrelevant operations. Such errors highlight difficulties in decoding mathematical language embedded within narrative structures. They also suggest that the student relied on procedural recall rather than conceptual mapping. The figure reflects the broader pattern observed among learners with limited connection ability.

Discussion

The improvement observed across the two meetings suggests that repeated engagement with story problems helps students gradually refine their reasoning pathways. This pattern supports previous research indicating that conceptual connections strengthen over time as learners revisit familiar structures within varied contexts (Anugraheni et al., 2025). Nevertheless, the persistent gap

in real-life application shows that contextual understanding does not automatically emerge from representational fluency alone (Saimon et al., 2025). Learners therefore require explicit opportunities to negotiate meaning, discuss alternative strategies, and articulate reasoning within classroom discourse. Such interaction aligns with evidence that communicative engagement enhances conceptual integration in mathematics learning (Ross et al., 2025). Differences among high-, medium-, and low-performing students further suggest that conceptual integration develops at varying rates depending on prior knowledge and interpretive habits. Similar patterns have been reported in studies on mathematical modelling, where learners' conceptual readiness influences their ability to connect ideas across contexts (Geiger et al., 2025; Tasarib et al., 2025). Overall, these findings reinforce the view that mathematical connection ability is both a cognitive and linguistic process requiring coordinated teacher support to foster meaningful learning and stable reasoning (Weingarden et al., 2026; Edson et al., 2025).

Implications

The study provides clear evidence that classroom instruction must intentionally integrate linguistic comprehension with mathematical reasoning to strengthen connection ability. Teachers should design learning experiences that emphasize discussion, contextual interpretation, and representation building. This approach supports students in constructing meaning beyond procedural recall and encourages them to relate mathematical ideas to real-life contexts. Curriculum developers can use these findings to refine problem-solving tasks so they better promote integrative thinking. Ultimately, the results underscore the importance of explicit scaffolding for conceptual linking in early mathematics education.

Limitations

This study involved a small number of participants, which limits the generalizability of the findings to broader populations. The qualitative design prioritizes depth of insight but cannot capture large-scale patterns in connection ability. Classroom dynamics and teacher-student interactions may have influenced students' performance in ways not accounted for in the analysis. The study also focused solely on story-problem contexts, leaving other forms of mathematical tasks unexplored. Future research should include larger sample sizes and diverse instructional settings to expand interpretive robustness.

Suggestions

Future studies should examine how explicit instruction in mathematical language influences students' connection-making processes. Researchers may also explore how multimodal supports, such as gestures or visual models, enhance comprehension during story-problem solving. Comparative studies across grade levels could reveal developmental trajectories in conceptual linking. Teachers are encouraged to incorporate structured discourse routines that allow students to verbalize reasoning and negotiate meaning. Cross-disciplinary research involving literacy specialists may further strengthen understanding of how language and mathematics intersect in early learning.

CONCLUSION

This study demonstrates that students' mathematical connection ability is closely related to how they interpret linguistic information, organize contextual meaning, and translate it into mathematical representations. Learners with higher problem-solving proficiency showed stronger

integration across representations, while those with lower proficiency experienced difficulties aligning story contexts with mathematical structures. These findings indicate that conceptual connection does not develop automatically but requires instructional support that emphasizes reasoning, interpretation, and meaning-making. Classroom practices that rely heavily on memorization limit students' opportunities to build deeper conceptual links across contexts. Therefore, strengthening mathematical connections in early grade classrooms requires sustained teacher scaffolding, contextual problem-solving tasks, and learning environments that actively engage students in articulating and negotiating mathematical meaning.

AUTHOR CONTRIBUTION STATEMENT

Maria Editha Bela was responsible for the conception and design of the study, including the development of research instruments and the selection of participants. She conducted all stages of data collection, comprising classroom observations, written assessments, and semi-structured interviews. She carried out the data analysis using the qualitative framework adopted in the study and interpreted the findings in relation to existing literature. She drafted the full manuscript, revised each section for clarity and coherence, and ensured the alignment of the article with international academic standards. She approved the final version of the manuscript and is accountable for all aspects of the work.

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