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Enhancing Fraction Learning: The Effectiveness of a Specialized Textbook for Slow Learners in Elementary Schools

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Abstrak

Penelitian ini bertujuan untuk mendeskripsikan efektivitas buku teks pecahan bagi siswa slow learner di sekolah dasar. Desain penelitian yang digunakan adalah one group pretest-posttest. Sampel penelitian adalah siswa slow learner. Materi yang digunakan dalam penelitian ini adalah pecahan. Data penelitian diperoleh melalui pretest dan posttest. Analisis pretest-posttest dilakukan dengan menggunakan perhitungan N-Gain. Hasil penelitian menunjukkan bahwa hasil belajar siswa slow learner (N-Gain) berada pada kategori sedang. Berdasarkan hasil tersebut, buku teks pecahan efektif dalam meningkatkan penguasaan konsep siswa slow learner, dan mengimplikasikan bahwa buku teks serupa dapat menjadi alternatif bahan ajar yang mendukung pembelajaran pecahan bagi siswa slow learner.

Abstract

This study aims to describe the effectiveness of a fraction textbook for slow-learner students in elementary schools. The research design employed was a one-group pretest–posttest design. The sample consisted of slow-learner students, and the learning material used in this study was fractions. Research data were obtained through pretests and posttests, and the pretest–posttest analysis was conducted using the N-Gain calculation. The results show that the learning outcomes of slow-learner students (N-Gain) fall into the medium category. Based on these findings, the fraction textbook is effective in improving slow-learner students' conceptual understanding and implies that similar textbooks may serve as alternative learning resources to support fraction learning for slow-learner students.

Keywords: *Effectiveness, Textbook, Fraction, Slow Learner*

INTRODUCTION

Mathematics is a discipline that holds a fundamental position in the development of human knowledge and daily life. Its applications extend far beyond the realm of exact sciences, touching various fields such as economics, social sciences, technology, and everyday problem-solving. For this reason, mathematics must be systematically taught at every level of education. In the school context, mathematics serves as a foundational subject that equips students with essential competencies for present and future challenges. Mathematical understanding supports practical daily needs, enhances work-related skills, and

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develops students' abilities to think critically and solve problems. This aligns with international educational frameworks, such as the OECD (2019), which emphasize mathematical literacy as a crucial competence in the 21st century.

In Indonesia, mathematics is taught universally from primary to higher education. The right to receive quality education is guaranteed through Law Number 20 of 2003, which ensures equal educational opportunities for all citizens, including those categorized as slow learners. The term *slow learner* refers to individuals who experience learning difficulties or whose academic progress is slower compared to their peers. They typically require extended time and modified instructional approaches to grasp and apply academic concepts (Murdiyanto et al., 2023). This condition may manifest across different educational settings and levels.

A substantial body of research has shown that slow learners frequently experience challenges in understanding various school subjects, including mathematics. They often struggle with abstract concepts, information processing, and applying learned skills to practical situations (Hafidah & Rukli, 2022; Sovia & Herman, 2019). Empirical data collected through interviews with slow learners in an elementary school in Kerinci Regency supports these findings. Among several mathematical topics, fractions emerged as one of the most difficult. Diagnostic assessments administered to students revealed misunderstandings, such as the inability to equalize denominators correctly—indicating a lack of mastery of the Least Common Multiple (LCM). As shown in Figure 1, such difficulties result in incorrect solutions.

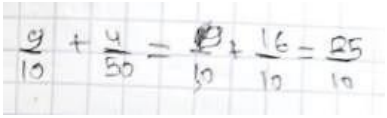

Figure 1. Slow Learner Answers

Similar patterns have been documented in other studies. Sovia et al. (2019) and Tran et al. (2019) found that slow learners tend to struggle significantly when performing fractional operations. Research by Novitasari (2018) further demonstrated that slow learners in inclusive settings frequently make errors when solving fraction-related problems. These recurring findings show that conceptual understanding of fractions remains a major challenge for this learner group.

Several previous studies have attempted to provide learning support for slow learners, particularly in mathematics. Sovia et al. (2019) developed remedial worksheets to support slow learners in understanding basic arithmetic operations, while Tran et al. (2019) emphasized the use of visual aids to improve conceptual comprehension in fraction learning. Novitasari (2018) designed differentiated learning modules that offered step-by-step guidance to accommodate students' slower processing pace. Although these studies have contributed valuable insights, most focus on supplementary materials such as worksheets, modules, or visual tools rather than the development of a comprehensive textbook specifically tailored for slow learners. Additionally, existing materials tend to target only certain skills or provide partial scaffolding, leaving a gap in the availability of structured and continuous learning resources designed wholly around the characteristics of slow learners.

Given these conditions, appropriate learning support is essential to help slow learners achieve optimal learning outcomes. Support mechanisms may include differentiated instructional strategies, additional guidance from teachers or specialists, curriculum adjustments tailored to individual needs, and accessible learning resources. This is consistent with the view of Dasaradhi et al. (2016), who highlight the importance of providing reading materials—such as textbooks, journals, magazines, and

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storybooks—that align with the interests and competencies of slow learners.

Textbooks, as one of the primary learning resources, play a central role in facilitating student learning. However, observations conducted in five schools in the suburban areas of DKI Jakarta revealed that none of these schools had textbooks specifically designed for slow learners. Available books were conventional textbooks intended for general students; thus, they did not adequately support the unique learning characteristics of slow learners. In contrast, inclusive education principles emphasize the importance of ensuring that every student, including those with learning difficulties, has equitable access to appropriate learning materials and opportunities.

To address this gap, previous research has developed a textbook designed based on the specific needs and characteristics of slow learners. The textbook adopts a contextual approach by presenting problems related to students' daily experiences. It includes detailed explanations and example questions to support comprehension, guided exercises with clear instructions to accommodate students who struggle to work independently, and independent practice sections to help assess mastery. Compared to earlier works that provide only partial or supplementary instructional supports, this textbook offers a comprehensive, structured, and contextually grounded learning resource dedicated specifically to slow learners. This represents the state of the art, as it integrates contextualization, scaffolding, and independent practice into a unified format tailored to learners with slower cognitive processing. After the development stage, it becomes essential to examine the effectiveness of the textbook. The effectiveness of teaching materials refers to their capacity to improve student learning outcomes following their use (Amirulmukminin & Purnama, 2023). Therefore, this article aims to evaluate the effectiveness of the developed textbook in supporting mathematics learning for slow learners.

METHODS

This study employed a one-group pretest–posttest design, which is commonly used to measure the effectiveness of an instructional intervention by comparing participants' performance before and after treatment. The analysis focused on the normalized gain (N-Gain), which is widely recognized as an appropriate indicator of effectiveness because it quantifies the proportion of improvement relative to the maximum possible score gain (Hake, 1998). This design allows researchers to directly observe learning improvement attributable to the use of the developed textbook (Creswell & Creswell, 2021; Fraenkel et al., 2019). No control group was included because the focus of this research was to examine changes in slow learners' mathematics performance after using the textbook.

The research was conducted in five different elementary schools located in suburban areas known to have a relatively high number of slow learners. Participant selection was carried out using a purposive sampling technique, which is appropriate when participants must meet specific predefined criteria (Etikan, 2020). A total of 50 slow learner students were involved in this study—10 students from each school. Students were selected from the lowest grade levels in each school and had been previously identified by their teachers as slow learners based on their learning characteristics and academic performance.

The primary instrument used in this research was a learning outcomes test. A test is an assessment tool designed to measure an individual's qualities, abilities, skills, or knowledge (McMillan & Schumacher, 2020). The test items were constructed to assess students' conceptual understanding of fractions, with indicators comprising: (1) fractional numbers, (2) equivalent fractions, (3) comparison and simplification of

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fractions, (4) fraction forms, and (5) fractional operations. All indicators were aligned with the learning objectives and the content presented in the developed textbook. In this study, the test was used to collect data on students' mathematics learning outcomes. The same test was administered as a pretest (before students used the textbook) and a posttest (after learning with the textbook). The questions were adopted from the independent practice section of the textbook to ensure content alignment and to maintain consistency of measurement.

The test consisted of 24 items, including 5 items on fractional numbers, 4 items on equivalent fractions, 5 items on fraction comparison and simplification, 5 items on fraction forms, and 5 items on fraction operations. To avoid overwhelming slow learners, the test trials were administered separately at each school, allowing students to work within a familiar and less stressful environment. Adjusting test administration in this manner is recommended for students with learning difficulties to minimize anxiety and cognitive overload (Aksoy & Diken, 2023).

Table 1. Trial Materials and Schools

No.	Sub-Material	Question items	Trial School
1	Fractional numbers	5	SDN A
2	Equivalent fractions	4	SDN B
3	Comparison of fractions and simplification of fractions	5	SDN C
4	Fraction form	5	SDN D
5	Fractional operations	5	SDN E

Before use, all test items had been validated during the textbook development phase, and the results indicated that the items were in the valid category. After administering the pretest and posttest, the effectiveness of the textbook was determined by examining the improvement in students' learning outcomes using the N-Gain score, which measures the magnitude of improvement relative to the maximum possible score (Hake, 1998, as cited in Amirulmukminin & Aprianti, 2019). The decision not to conduct a hypothesis test, such as a paired sample *t*-test, was based on the primary objective of this study, which was to evaluate the practical significance and magnitude of learning improvement rather than to test statistical significance. In one-group pretest–posttest designs, the N-Gain score is widely used in educational research to quantify instructional effectiveness because it directly describes the extent of improvement attributable to the intervention (Hake, 1998; Meltzer, 2002). Additionally, statistical significance alone does not necessarily indicate meaningful learning gains, especially in small samples; therefore, the use of N-Gain provides a more informative measure of instructional impact in line with recommendations from educational design research that emphasize descriptive evidence of learning improvement over purely inferential outcomes (Akker et al., 2013; Plomp & Nieveen, 2013).

The formula for the N-Gain calculation is as follows:

$$g = \frac{S_{pos} - S_{pre}}{S_{max} - S_{pre}}$$

Information:
S_{pos}= Posttest score
S_{Pre}= Pretest score
S_{max}= Maximum score
The N-Gain results were then interpreted based on the classification proposed by Meltzer (2002).

Tabel 2. N-Gain Classification

The magnitude of g	Interpretation
$g > 0{,}7$	High
$0{,}3 < g \leq 0{,}7$	Medium
$g \leq 0{,}3$	Low

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RESULT AND DISCUSSION

Learning activities began with administering a pretest to slow learners to measure their initial understanding of fractional concepts. After completing the pretest, students were guided to study the material in the textbook independently. During this process, the teacher provided opportunities for students to ask questions about concepts that were unclear and encouraged them to complete the guided practice tasks contained in the textbook. After students finished the learning activities, the teacher administered a posttest using the same items as the pretest, ensuring consistency in measuring students' progress.

The collected data were analyzed to determine the effectiveness of the textbook. Effectiveness was assessed by comparing the improvement in students' learning outcomes, which was calculated using the N-Gain score. The average N-Gain score reflects the level of improvement resulting from the intervention (Hake, as cited in Amirulmukminin & Aprianti, 2019). The N-Gain values obtained for each sub-material are presented in the following table.

Table 3. N-Gain of Each Sub-Material

No.	Sub-Material	Trial School	Pretest	Posttest	N-Gain	Category
1	Fractional numbers	SDN A	16	76	0.71	High
2	Equivalent fractions	SDN B	17	65	0.58	Medium
3	Comparison of fractions and simplification of fractions	SDN C	26.25	69	0.59	Medium
4	Fraction form	SDN D	37.1	89.3	0.82	High
5	Fractional operations	SDN E	14.3	24.3	0.11	Low

Based on Table 3, all sub-materials experienced an increase between pretest and posttest scores. The highest improvement occurred in the sub-materials *fractional numbers* and *fraction form*, both categorized as high. This suggests that these materials may be relatively more accessible to slow learners due to lower levels of abstraction. Similar findings have been reported in studies showing that slow learners perform better on concrete or semi-concrete mathematical tasks compared to highly abstract reasoning tasks (Kaur & Singh, 2021; Widodo & Sari, 2022).

The sub-materials *equivalent fractions* and *comparison and simplification of fractions* exhibited improvements within the **medium** category. These results indicate that although students showed progress, the concepts involved required higher levels of cognitive processing, particularly in identifying relationships between numbers and performing transformations on fractional representations. Research indicates that tasks requiring multi-step reasoning often pose challenges for slow learners because of limited working memory capacity and difficulties with symbolic manipulation (Alhasson, 2023; Peng et al., 2019).

Meanwhile, the sub-material *fractional operations* showed the lowest improvement, categorized as low. Fraction operations (addition, subtraction, multiplication, division) are widely recognized as one of the most difficult components of fraction learning, especially for students with learning difficulties. This is consistent with previous findings that operations on fractions require strong conceptual understanding and procedural fluency—areas where slow learners typically

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face barriers (Ames & Watson, 2022; Rahmawati & Putra, 2021).

The comparison of pretest and posttest scores for each material is illustrated in the following figure.

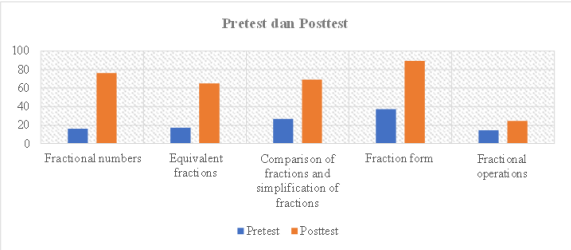

Figure 2. Comparison graph of pretest and posttest scores

When the average N-Gain across all sub-materials was calculated, the value obtained was 0.56, which falls in the medium category. A medium N-Gain indicates that students experienced a meaningful improvement in learning outcomes after using the textbook. This supports the conclusion that the textbook was effective for enhancing the understanding of slow learners in fractional topics, in line with Rosida et al. (2018).

The effectiveness of the textbook can be attributed to several key components embedded within the learning materials:

1. Clear and detailed explanations
   Slow learners benefit from step-by-step explanations that reduce cognitive load and support conceptual clarity (Rasmitadila & Goldstein, 2017; Hidayah et al., 2020).
2. Worked examples and guided practice
   Worked examples are known to help students internalize procedures, especially those who struggle with abstract reasoning. These examples in the textbook strengthened students' grasp of each concept (Salomi, 2018).
3. Contextual problems related to real-life situations
   Presenting mathematical problems within familiar contexts helps slow learners visualize concepts that might otherwise feel abstract (Shaw, 2010; Nugroho & Lestari, 2023).
4. Practice tasks with step-by-step instructions
   Tasks structured in sequential steps support gradual skill acquisition, an approach recommended for learners with processing difficulties (Vasudevan, 2017; Aksoy & Diken, 2023).

Overall, the results demonstrate that the developed textbook effectively facilitated slow learners' understanding of fractions, although certain sub-materials particularly fractional operations may require additional instructional support or supplementary scaffolding.

The findings of this study are aligned with previous research emphasizing that structured, scaffolded, and visually supported instructional materials are highly beneficial for students with learning difficulties. Systematic reviews on scaffolding strategies in mathematics learning have demonstrated that students show significant improvement when instructional resources incorporate clear sequencing, worked examples, and visual representations (Kusmaryono & Wijayanti, 2020). These characteristics were intentionally embedded in the developed textbook and may explain the medium-to-high N-Gain scores observed in most sub-materials. Research also indicates that scaffolded learning environments are particularly effective for learners who require additional support, as they help reduce cognitive barriers and facilitate understanding of foundational concepts (Chairani, 2015).

However, the low improvement observed in fractional operations indicates that while conceptual understanding improved, procedural fluency remains a challenge. This is consistent with findings from cognitive load theory, which demonstrate that multi-step procedures—such as operations on fractions—impose a higher intrinsic cognitive load, making them more difficult for students with limited

working memory capacity (Rahmawati, Ardianzah, & Novitasari, 2024). Studies further show that when task complexity is high, learners require intensified scaffolding, guided practice, and repeated exposure to minimize cognitive overload (Auliah et al., 2025). This suggests that additional instructional support may be necessary for procedural components beyond what the textbook alone can provide.

The findings also support sociocultural perspectives on learning, which emphasize the role of guided assistance and structured support within the learner's zone of proximal development. Instructional scaffolding—through features such as worked examples, step-by-step explanations, and contextualized tasks—has been shown to enable students to achieve learning outcomes beyond their independent capabilities (Kusmaryono & Wijayanti, 2020). This implies that well-designed textbooks can function not only as content references but also as pedagogical tools that mediate learning for students with diverse cognitive needs.

In terms of implications, this study indicates that textbooks specifically designed for slow learners—with features such as sequential explanations, contextual problems, and scaffolded practice—can significantly enhance their mastery of fundamental mathematical concepts. For teachers, these findings highlight the importance of integrating materials that reduce cognitive load and provide systematic, structured guidance. For curriculum developers, the results underscore the need for differentiated instructional materials tailored to learners with persistent difficulties. Future research may extend this work by employing controlled experimental designs or exploring how digital scaffolding and manipulatives might enhance learning outcomes in more complex fraction operations.

CONCLUSION

Based on the results and discussion, it can be concluded that the fraction textbook developed in this study is effective for supporting slow learners' mathematics learning, as indicated by an average N-Gain score of 0.56 within the medium category. The improvements achieved show that the textbook's components such as clear explanations, contextual examples, and step-by-step guided practice successfully accommodated the learning needs of slow learners. Therefore, this textbook is suitable for use by teachers as an instructional resource to facilitate slow learners' understanding of fraction concepts. In addition, future research may employ more rigorous designs, such as controlled experiments, to further validate the textbook's effectiveness. Studies with larger and more diverse samples are also recommended, as well as investigations into the use of digital or manipulative-based supports to help slow learners master more complex fraction operations.

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