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DAKON MEDIA WITH GUIDED DISCOVERY TO IMPROVE PRIMARY STUDENTS' MATHEMATICAL UNDERSTANDING AND REASONING

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Abstract

Conceptual understanding and mathematical reasoning are essential foundations for students' mastery of multiplication and division in primary school. The initial classroom diagnosis showed that many third-grade students still learned multiplication and division procedurally and had difficulty connecting concrete situations, visual representations, and mathematical symbols. This classroom action research aimed to improve students' conceptual understanding and mathematical reasoning through dakon mathematics media integrated with Guided Discovery Learning and the Concrete–Representational–Abstract pathway. The study involved 31 third-grade students of SD Muhammadiyah Sapen Yogyakarta during January and February 2026 in the second semester of the 2025/2026 academic year. The action was conducted in two cycles consisting of planning, action implementation, observation, and reflection. Data were collected through conceptual understanding tests, mathematical reasoning tasks, observation sheets, and brief interviews. The findings showed that students' conceptual mastery improved progressively. The percentage of students achieving mastery increased from 32.26% in the pre-action stage to 58.06% in Cycle I and 77.42% in Cycle II. The class average increased from 69.35 in Cycle I to 79.35 in Cycle II. Mathematical reasoning improved from a mean score of 8.71 in Cycle I to 9.68 in Cycle II. These results indicate that dakon media, when supported by guided discovery and structured representational transition, can strengthen students' conceptual connections, justification, strategy comparison, and answer verification. The study concludes that culturally familiar manipulatives are effective when their use is integrated with reflective questioning and systematic representation.
Keywords: *dakon media; guided discovery learning; conceptual understanding; mathematical reasoning; primary mathematics*

Abstrak

Pemahaman konsep dan penalaran matematis merupakan landasan penting bagi siswa sekolah dasar dalam menguasai materi perkalian dan pembagian. Diagnosis awal di kelas menunjukkan bahwa banyak siswa kelas III masih mempelajari perkalian dan pembagian secara prosedural serta mengalami kesulitan dalam menghubungkan situasi konkret, representasi visual, dan simbol matematika. Penelitian tindakan kelas ini bertujuan untuk meningkatkan pemahaman konsep dan penalaran matematis siswa melalui media dakon matematika yang dipadukan dengan Guided Discovery Learning dan lintasan Concrete–Representational–Abstract. Penelitian ini melibatkan 31 siswa kelas III SD Muhammadiyah Sapen Yogyakarta pada Januari dan Februari 2026 dalam semester genap tahun ajaran 2025/2026. Tindakan dilaksanakan dalam dua siklus yang meliputi perencanaan, pelaksanaan tindakan, observasi, dan refleksi. Data dikumpulkan melalui tes pemahaman konsep, tugas penalaran matematis, lembar observasi, dan wawancara singkat. Hasil penelitian menunjukkan bahwa penguasaan konsep siswa meningkat secara bertahap. Persentase siswa yang mencapai ketuntasan meningkat dari 32,26% pada tahap pratindakan menjadi 58,06% pada Siklus I dan 77,42% pada Siklus II. Rata-rata kelas meningkat dari 69,35 pada Siklus I menjadi 79,35 pada Siklus II. Penalaran matematis meningkat dari skor rata-rata 8,71 pada Siklus I menjadi 9,68 pada Siklus II. Hasil ini menunjukkan bahwa media dakon yang didukung penemuan terbimbing dan transisi representasi terstruktur dapat memperkuat koneksi konsep, pemberian alasan, perbandingan strategi, dan verifikasi jawaban siswa. Penelitian ini menyimpulkan bahwa media manipulatif yang dekat dengan budaya siswa efektif apabila diintegrasikan dengan pertanyaan reflektif dan representasi yang sistematis.
Kata Kunci: media dakon; guided discovery learning; pemahaman konsep; penalaran matematis; matematika sekolah dasar

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Introduction

Mathematics learning in primary school is not only intended to develop computational skills but also to cultivate students' ability to understand concepts, identify relationships among ideas, and use reasoning to solve problems. In the topic of multiplication and division of whole numbers, students need to understand the meaning of the number of groups, the number of members in each group, the total quantity, and the relationship between multiplication and division as interconnected operations. When the material is introduced directly through symbols or computational procedures, some students tend to memorize steps without understanding the conceptual structure underlying the operations.

This condition was evident in mathematics learning in Grade III at SD Muhammadiyah Sapen Yogyakarta. The initial classroom diagnosis showed that many students had not yet understood multiplication as repeated addition or division as equal grouping. Students also experienced difficulties when asked to transform contextual situations into concrete or visual models and then express them in mathematical sentences. Of the 31 students, only 10 students, or 32.26%, reached the minimum mastery criterion of 78 in the initial test. Classroom observations also showed that students focused more on obtaining final answers than on giving reasons, comparing strategies, or checking the correctness of their answers.

These problems need to be addressed through learning that aligns with the cognitive development characteristics of primary school students. Piaget (1952) explains that primary school-aged children are generally in the concrete operational stage, which means they understand abstract concepts more easily when learning begins with direct and concrete experiences. In mathematics learning, such concrete experiences should be gradually directed toward visual representations and mathematical symbols. The Concrete–Representational–Abstract approach is therefore relevant because it provides a pathway from manipulating concrete objects to creating visual models and finally using formal mathematical symbols.

The use of manipulatives has a strong empirical foundation in mathematics education. Carbonneau et al. (2013) show that concrete manipulatives can support mathematics achievement, particularly when their use is accompanied by adequate instructional guidance. Hurst and Linsell (2020) emphasize that manipulatives do not automatically produce understanding, but they can become important tools for developing multiplicative thinking when teachers explicitly connect manipulative activities with mathematical structures. Thus, the use of concrete media needs to be combined with pedagogical strategies that encourage students to discover meaning rather than merely move objects.

Dakon mathematics media has potential as a concrete medium that is close to students' cultural experiences. The structure of dakon, consisting of holes and seeds, can be used to visualize groups, members of groups, totals, remainders, and distribution. In multiplication, dakon seeds can illustrate the number of groups and the number of members in each group. In division, the activity of distributing seeds into dakon holes can help students understand equal sharing, grouping, and the interpretation of remainders. This medium not only provides physical activity but also helps students recognize the mathematical structure of basic arithmetic operations.

To prevent dakon from being used merely as a game or manipulative activity, this study integrates it with Guided Discovery Learning. This model positions the teacher as a facilitator who provides guiding questions, examples and non-examples, opportunities for exploration, strategy discussions, and reflection. Bruner (1961) views discovery as an important learning process because students have opportunities to construct meaning through experience. In the context of primary mathematics, Guided Discovery Learning can help students connect concrete activities with more formal mathematical concepts and reasoning. Arifin et al. (2020) also show that contextual guided discovery learning can improve students' mathematical understanding and reasoning.

Previous studies have widely discussed manipulative media, discovery learning, and visual representation as separate components. However, the use of dakon media is often positioned only as a learning aid to improve achievement or motivation, while students' transition across representations and the development of mathematical reasoning are not always examined in an integrated way. In addition, studies on guided discovery frequently emphasize problem solving or learning outcomes, but they do not necessarily combine culturally familiar manipulatives with a systematic pathway from concrete experience to visual representation and mathematical symbols. Therefore, the novelty of this study lies in the integration of dakon media, Guided Discovery Learning, and the Concrete–Representational–Abstract pathway in one classroom action design. This integration is intended not only to improve students' mastery of multiplication and division but also to strengthen their ability to explain reasons, compare strategies, verify answers, and connect contextual situations, concrete models, visual representations, and symbolic notation.

Based on this background, this study aims to describe the implementation of mathematics learning using dakon media based on Guided Discovery Learning, analyze the improvement of students' conceptual understanding of multiplication and division of whole numbers, and analyze the improvement of third-grade students' mathematical reasoning.

Research Methods

This study employed Classroom Action Research using the Kemmis and McTaggart spiral model, which consists of planning, action implementation, observation, and reflection. This design was chosen because the study focused on improving classroom learning practices directly through actions that were planned, implemented, observed, and revised cyclically. The research was conducted in Grade III Mansur Al Kamili at SD Muhammadiyah Sapen Yogyakarta during January and February 2026 in the second semester of the 2025/2026 academic year. The research subjects consisted of 31 students.

The learning action was designed by integrating dakon mathematics media, Guided Discovery Learning, and the Concrete–Representational–Abstract pathway. At the concrete stage, students used dakon seeds and holes to form equal groups, demonstrate repeated addition, and model division. At the representational stage, students drew arrays, tables, or group models based on their dakon activities. At the abstract stage, students wrote mathematical sentences and solved problems using operation symbols. Guided Discovery Learning was implemented through the presentation of contextual problems, guiding questions, group exploration, processing of findings, verification, and conclusion drawing.

Data were collected using four techniques. The first technique was a conceptual understanding test across representations, consisting of 10 essay items with a maximum score of 20. The indicators of conceptual understanding included identifying the meaning of multiplication and division in contextual situations, representing equal groups using concrete or visual models, translating models into mathematical symbols, and explaining the relationship between multiplication and division. The second technique was mathematical reasoning tasks that assessed four indicators, namely explaining solution steps, giving logical reasons, comparing strategies, and checking answers using relevant mathematical relationships. The total reasoning score ranged from 4 to 16. The third technique was observation sheets used to assess the implementation of Guided Discovery Learning and the Concrete–Representational–Abstract stages, including problem orientation, guided exploration, representation transition, discussion, verification, and conclusion drawing. The fourth technique was brief interviews or question-and-answer sessions conducted to obtain supporting information about students' responses to the learning process and the difficulties they experienced during the transition from concrete activities to symbolic notation.

Data validity was strengthened through content validity of the instruments, scoring consistency, and methodological triangulation. Content validity was established through expert judgment regarding the alignment of indicators, test items, and scoring rubrics. Triangulation was conducted by comparing data from tests, observations, and interviews so that the findings were not based solely on scores but were also supported by observed learning processes.

Quantitative data were analyzed descriptively using means, mastery percentages, and comparisons across cycles. Individual mastery was set at a minimum score of 78 according to the school criterion, while classical mastery was achieved when at least 75% of students reached individual mastery. Mathematical reasoning scores were analyzed by comparing the mean scores and achievement categories from the pre-action stage, Cycle I, and Cycle II. Observation and interview data were analyzed qualitatively through data reduction, data display, and conclusion drawing to explain supporting factors and obstacles during the action.

Results and Discussion

The pre-action results showed that students' conceptual understanding of multiplication and division was still low. Of the 31 students, only 10 students, or 32.26%, achieved mastery, while 21 students, or 67.74%, had not yet achieved mastery. The initial class average was 60. The analysis of students' answers showed that some students could obtain the results of simple operations, but they were not yet consistent in connecting contexts, pictures, and symbols. In multiplication problems, several students could not yet interpret group arrangements as repeated addition. In division problems, students still had difficulty understanding the meaning of equal sharing and interpreting remainders.

In terms of reasoning, the pre-action mean score was 8.52 out of a maximum score of 16, which was categorized as sufficient. Students were generally not accustomed to explaining the reasons behind their solution steps. When asked to compare two strategies, some students only mentioned the method they considered faster without explaining its mathematical basis. Checking answers had also not yet become part of students' thinking habits. This condition indicated that the learning action needed to focus on developing conceptual understanding across representations while also habituating mathematical reasoning.

In Cycle I, the teacher implemented learning using dakon mathematics media through the stages of Guided Discovery Learning. The lesson began with contextual problems related to grouping objects. Students then used dakon to model the number of groups and the number of members in each group. After that, they drew group arrangements or arrays and wrote the corresponding mathematical sentences. The teacher provided guiding questions such as "How many groups are formed?", "How many objects are in each group?", "How can this picture be written as a mathematical sentence?", and "Why is this answer correct?".

The results of Cycle I showed improvement compared with the pre-action stage. The number of students achieving mastery increased to 18 students, or 58.06%, while 13 students, or 41.94%, had not yet achieved mastery. This increase indicates that dakon began to help students build relationships between concrete activities and mathematical symbols. Some students started to model multiplication in the form of rows and columns and then write it as a multiplication sentence. Nevertheless, reflection on Cycle I showed that students' understanding was not yet fully stable. In problems that required students to connect multiplication and division, inconsistencies between pictures and symbols were still found. Some students were able to arrange dakon seeds correctly but could not yet write the appropriate mathematical sentence. In terms of reasoning, the mean score increased from 8.52 to 8.71. This increase was still limited because many students needed follow-up questions to explain their reasons. Activities involving strategy comparison and answer checking began to appear but had not yet been carried out independently by most students.

Based on this reflection, the action in Cycle II was improved by emphasizing three aspects. First, the teacher clarified the transition from dakon to pictures and symbols through examples and non-examples. Second, students were given more time to compare solution strategies in group discussions. Third, the teacher encouraged students to verify answers using inverse operations, for example by checking division results through multiplication. In Cycle II, learning continued to use dakon media, but the representational flow was made more explicit. Students were not only asked to arrange dakon seeds but also to explain the relationship among dakon arrangements, array pictures, group tables, and operation symbols. The teacher strengthened reflective discussions by asking students to respond to questions such as "Why is this method appropriate?", "Is there another method?", and "How can you prove that your answer is correct?".

The results of Cycle II showed stronger improvement. The mean score for conceptual understanding increased from 69.35 in Cycle I to 79.35 in Cycle II. The number of students achieving mastery increased to 24 students, or 77.42%, while 7 students, or 22.58%, had not yet achieved mastery. Therefore, the minimum classical mastery indicator of 75% was achieved. This improvement indicates that the consistent implementation of the concrete, representational, and abstract stages helped students build connections among different forms of representation.

Table 1. Students' Conceptual Understanding Mastery

Stage	Students Achieving Mastery	Mastery Percentage	Students Not Yet Achieving Mastery	Non-Mastery Percentage
Pre-action	10	32.26%	21	67.74%
Cycle I	18	58.06%	13	41.94%
Cycle II	24	77.42%	7	22.58%

Source: Research data, January and February 2026

In terms of mathematical reasoning, the mean score increased from 8.71 in Cycle I to 9.68 in Cycle II. This increase indicates that students began to develop their ability to give reasons, compare strategies, and check answers. Students who previously only explained procedures began to refer to the concept of equal grouping, the relationship between the number of groups and the number of members in each group, and inverse operations. Some students also began to compare two strategies, such as repeated addition and arrays, and explain which strategy was more efficient.

Table 2. Students' Mean Mathematical Reasoning Scores

Stage	Mean Score	Category
Pre-action	8.52	Sufficient
Cycle I	8.71	Sufficient
Cycle II	9.68	Good

Source: Research data, January and February 2026

Qualitatively, observations showed that discussions in Cycle II became more focused. Students were more active in presenting their dakon arrangements, explaining their pictures, and connecting them with symbols. When different answers emerged, the teacher did not immediately determine the correct answer but asked students to test their strategies through re-manipulation or inverse operations. This situation strengthened the role of Guided Discovery Learning as a framework that guides students to discover concepts through exploration and reflective questioning.

The improvement in conceptual understanding in this study can be explained through the integration of dakon media, the Concrete–Representational–Abstract pathway, and Guided Discovery Learning. Dakon media functioned as a concrete representation that allowed students to directly observe the structure of multiplication and division. In multiplication, dakon holes represented the number of groups, while dakon seeds represented the members of each group. In division, the activity of distributing seeds into dakon holes helped students understand equal sharing, grouping, and the interpretation of remainders. This concrete experience was important because multiplication and division are not merely computational procedures; they involve relationships among quantities that must be represented meaningfully. The findings support Piaget's view that primary school students require concrete experiences to understand abstract concepts and are also in line with the representational logic of the Concrete–Representational–Abstract approach.

However, concrete media alone are not sufficient unless they are explicitly connected to mathematical concepts. Hurst and Linsell (2020) emphasize that manipulatives need to be used purposefully so that students do not merely engage in physical activity. In this study, this connection was built through the Concrete–Representational–Abstract stages. After manipulating dakon seeds, students drew arrangements or tables and then expressed them using mathematical symbols. This transition helped students understand that a symbol such as 4×3 is not merely a computational procedure but a representation of four groups, each consisting of three members. This finding is also consistent with Carbonneau et al. (2013), who show that manipulatives are more effective when supported by instructional guidance. In this study, such guidance appeared through guiding questions, group discussions, examples and non-examples, and answer verification. Therefore, the improvement in conceptual understanding was not solely caused by the presence of dakon media, but by the systematic connection among concrete experience, visual representation, symbolic notation, and teacher-guided reflection.

Mathematical reasoning improved because the learning process did not focus solely on final answers. Each dakon activity was followed by questions that required students to explain their processes and reasons. Students were also asked to compare strategies, such as repeated addition, arrays, and multiplication sentences. This process encouraged students to recognize that several strategies could produce the same answer but differ in efficiency and representational clarity. In Cycle I, most students' reasons were still procedural. They explained their answers by saying "because it is multiplied" or "because it is divided" without relating them to the structure of groups. In Cycle II, students' reasons became more conceptual, for example by stating that groups must contain the same number of members or that a division answer could be checked through multiplication. This indicates a shift from procedural understanding toward more reflective reasoning.

Guided Discovery Learning played an important role in shaping this change. The teacher guided students through questions but did not immediately provide formulas. Students were given opportunities to try, model, discuss, revise, and draw conclusions. This learning sequence gave students space to construct mathematical meaning while still receiving scaffolding so that their discoveries remained directed toward the intended concepts. Arifin et al. (2020) explain that guided discovery can strengthen understanding and reasoning because students do not merely receive concepts but build relationships among contexts, representations, and procedures. The present study extends this idea by showing that guided discovery becomes more meaningful when supported by culturally familiar concrete media and a structured representational pathway. Therefore, the contribution of this study is not limited to proving that dakon can improve learning outcomes; it also shows how dakon can be used as a conceptual bridge to support representation, justification, and verification in primary mathematics learning.

Although the success indicators were achieved, this study has several limitations. The action was conducted in one class with 31 students, so the results are not intended for broad generalization. The study was conducted in two cycles, so it does not yet describe long-term retention of conceptual understanding. The assessment of mathematical reasoning used a rubric that still required careful interpretation, especially regarding the quality of students' written explanations. In addition, seven students had not yet achieved mastery by the end of Cycle II, so follow-up support is needed, especially in strengthening the transition from visual representations to abstract symbols.

Conclusion

The implementation of dakon mathematics media based on Guided Discovery Learning through the Concrete–Representational–Abstract pathway improved third-grade students' conceptual understanding and mathematical reasoning in multiplication and division of whole numbers at SD Muhammadiyah Sapen Yogyakarta. The action answered the classroom problem by helping students move from concrete manipulation to visual representation and mathematical symbols in a more systematic way. Dakon media provided concrete experiences, Guided Discovery Learning created opportunities for exploration and reflection, and the representational pathway helped students connect contextual situations, models, and mathematical notation. These integrated components encouraged students not only to obtain correct answers but also to explain reasons, compare strategies, and verify results. The findings imply that mathematics learning in lower primary grades should be designed to develop meaning and reasoning, not merely procedural fluency. Teachers are encouraged to use culturally familiar manipulatives purposefully, supported by guiding questions and assessment across representations. Future studies may examine the use of dakon media in other mathematics topics, different grade levels, or with additional measures of long-term conceptual retention.

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