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Innovation in Mathematics Learning through The Use of Straws and Number Pockets with A Differentiated Learning Approach

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Abstract

Low student interest in Mathematics, particularly in addition and subtraction operations, has resulted in low participation and learning outcomes that do not meet the Minimum Mastery Criteria (MMC) of 80. This study aims to improve students' learning outcomes through the use of *Straws* and number pocket learning media. This research employed a Classroom Action Research (CAR) design conducted in two cycles involving 28 first-grade students. Data were collected through learning evaluations and classroom observations. The results showed a significant improvement in students' achievement. In the first cycle, 46.43% of students achieved mastery with an average score of 76.25. This increased to 85.71% in the second cycle, with an average score of 83.71. These findings indicate that *Straws* and number pocket media effectively enhance students' understanding and problem-solving skills in basic arithmetic operations.

Keywords: Learning Outcomes; Mathematics; Instructional Media; arithmetic operations.

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Abstrak

Rendahnya minat peserta didik terhadap pembelajaran Matematika, khususnya pada materi operasi hitung penjumlahan dan pengurangan, berdampak pada rendahnya partisipasi dan hasil belajar. Kondisi ini terlihat dari capaian nilai peserta didik yang belum memenuhi Kriteria Ketuntasan Minimal (KKM) sebesar 80 di SDN Sidoarjo. Oleh karena itu, penelitian ini bertujuan untuk meningkatkan hasil belajar peserta didik melalui penerapan media pembelajaran *Straws* dan kantong bilangan dalam kegiatan pembelajaran. Penelitian ini menggunakan pendekatan Penelitian Tindakan Kelas (PTK) yang dilaksanakan dalam dua siklus. Subjek penelitian adalah 28 peserta didik kelas I, yang terdiri atas 10 siswa laki-laki dan 18 siswa perempuan. Teknik pengumpulan data dilakukan melalui evaluasi hasil belajar dan observasi aktivitas peserta didik selama proses pembelajaran. Hasil penelitian menunjukkan adanya peningkatan hasil belajar pada setiap siklus. Pada siklus I, jumlah peserta didik yang mencapai ketuntasan belajar sebanyak 13 orang (46,43%) dengan nilai rata-rata 76,25. Selanjutnya, pada siklus II terjadi peningkatan signifikan, yaitu sebanyak 24 peserta didik (85,71%) mencapai ketuntasan dengan nilai rata-rata 83,71. Temuan ini menunjukkan bahwa penggunaan media pembelajaran *Straws* dan kantong bilangan efektif dalam meningkatkan pemahaman konsep serta kemampuan peserta didik dalam menyelesaikan masalah pada materi operasi hitung penjumlahan dan pengurangan. Dengan demikian, penerapan media pembelajaran yang inovatif dan konkret dapat menjadi alternatif solusi dalam meningkatkan kualitas pembelajaran Matematika di sekolah dasar.

Kata kunci: Hasil Belajar; Matematika; Media Pembelajaran; Operasi Hitung.

INTRODUCTION

Mathematics is a fundamental subject that plays a crucial role in developing students' logical, analytical, and systematic thinking skills from the primary school level (Malikah et al., 2022), (Fauzi & Lu'luilmaknun, 2019). However, in practice, Mathematics learning is often perceived as difficult and less engaging, particularly in basic arithmetic operations such as addition and subtraction. This condition leads to low student interest, participation, and learning outcomes (Rudhito et al., 2020) (Rokhim & Patahuddin, 2020).

This problem was also identified among first-grade students at SDN Sidoarjo, where most students had not yet achieved the Minimum Mastery Criteria (MMC) of 80. This low level of achievement indicates that the learning process has not fully accommodated the diverse learning needs of students. One contributing factor is the continued use of conventional teaching methods that lack the integration of concrete learning media appropriate to the characteristics of early-grade learners (Fadilah et al., 2023), (Safitri et al., 2023).

At the primary level, students are generally in the concrete operational stage of development; therefore, they require tangible and manipulative learning media to help them understand abstract mathematical concepts (Marinda, 2020). Therefore, the use of concrete learning media is considered an effective alternative for improving students' conceptual understanding (Mubarak, 2025). In addition, differences in students' abilities, interests, and learning styles necessitate the implementation of a differentiated learning approach to ensure that the learning process is more adaptive and inclusive (Sanulita, 2023), (Fauzia & Hadikusuma Ramadan, 2023).

Several previous studies have shown that the use of concrete learning media and the implementation of differentiated instruction, when applied separately, can improve students' Mathematics learning outcomes. A study by (Maharani et al., 2023) demonstrated that manipulative media can enhance primary school students' conceptual understanding of basic arithmetic operations. Meanwhile, a study by (Dedik Susila & Istri Aryasuari, 2023) demonstrated that differentiated instruction is effective in increasing student engagement and improving learning outcomes. students. However, there are still limitations in studies that integrate both aspects simultaneously, particularly in teaching basic arithmetic operations in lower primary grades. In addition, research utilizing simple, locally available learning media that are easily accessible to teachers remains relatively limited (Dian Aprelia Rukmi et al., 2023).

Based on this condition, a research gap exists in the limited number of studies that integrate the use of concrete learning media with a differentiated learning approach within a coherent instructional design (Ultra Gusteti & Neviyarni, 2022), (Kurnia Fitra, 2022). Therefore, this study offers a novel contribution by integrating Straws and number pocket learning media with a differentiated instruction approach to improve students' learning outcomes in addition and subtraction operations (Harsiwi & Arini, 2020), (Arisandi, 2024).

Thus, this study is expected not only to improve students' learning outcomes but also to provide practical contributions for teachers in developing innovative, contextual, and student-centered instructional strategies that align with the characteristics of primary school learners.

Research Method

This study employed a Classroom Action Research (CAR) design. *(Siswani Mulia & Suwarno, 2020)*. According to Allwright, Dick, Bailey, and Kathleen (1991), Classroom Action Research (CAR) is a form of inquiry centered within the classroom, aiming to explore and understand phenomena that occur during the teaching and learning process.

The subjects of this study were first-grade students at SDN Sidoarjo, consisting of 28 students, including 18 female and 10 male students in the 2023/2024 academic year. The research was conducted during the second semester, beginning in the first week of the

learning process and continuing into the second week.

Data analysis in this study was carried out using both quantitative and qualitative approaches to obtain a comprehensive understanding of the improvement in students' learning outcomes and learning activities during the implementation of the intervention.

Quantitative data were obtained from students' learning evaluations in each cycle. The analysis was conducted by calculating the mean score to determine the average of students' learning outcomes, using the following formula:

$$\bar{X} = \frac{\sum X}{N}$$

Description:
X = mean (average) score
∑X = total of all students' scores
N = number of students

To determine the percentage of students who achieved the Minimum Mastery Criteria (MMC):

$$P = \frac{f}{N} \times 100\%$$

Description:
P = percentage of mastery
f = number of students who achieved mastery
N= total number of students

Table 1. Analysis of Students' Learning Outcomes

No	Cycle	Number of Students	Mean Score	Students	Percentage
1	Pre-Cycle	28	(initial data)	(fill)	(fill %)
2	Cycle I	28	76.25	13	46.43%
3	Cycle II	28	83.71	24	85.71%

No	Cycle	Sample	Mean Score	Students Achieving Mastery	%
1	Pre-Cycle	28	(initial data)	(fill)	(fill %)
2	Cycle I	28	76.25	13	46.43%
3	Cycle II	28	83.71	24	85.71%

The improvement in students' learning outcomes was analysed by comparing the results across cycles:

- Cycle I → Cycle II
- Based on the increase in mean scores and the percentage of mastery

Table 2. Improvement in Students' Learning Outcomes

Aspect	Cycle I	Cycle II	Improvement
Average Score	76.25	83.71	+7.46
Number of Students Achieving Mastery	13	24	+11
Mastery Percentage	46.43%	85.71%	+39.28%

Table 3. Observation of Students' Activities

No	Observed Aspects	Cycle I	Cycle II	Description
1	Activeness in learning	Fair	Good	Increased
2	Participation in discussions	Fair	Good	Increased
3	Use of learning media	Fair	Very Good	Significantly increased
4	Problem-solving skills	Poor	Good	Improved
5	Learning enthusiasm	Fair	Good	Increased

Table 4. Assessment Criteria

Score Interval	Category
85 – 100	Very Good
70 – 84	Good
55 – 69	Fair
< 55	Poor

The second qualitative data analysis was obtained from the observation of students' and teachers' activities during the learning process. The analysis was conducted through several stages: data reduction, which involves selecting and focusing on important data from the observation results; data presentation, which organizes the data into a descriptive narrative form; and conclusion drawing, which interprets changes in students' learning behavior.

The observed aspects included:

- Students' activeness in learning
- Participation in discussions
- Ability to use learning media
- Problem-solving skills
- Learning responses and motivation

The results of the qualitative analysis showed that:

- There was an increase in students' activeness from Cycle I to Cycle II
- Students became more enthusiastic in using Straws media and number bags
- Students began to be able to solve problems independently
- The interaction between teachers and students became more effective

Third, Research Success Indicators

This study is considered successful if:

1. At least 80% of students achieve the Minimum Mastery Criteria (KKM ≥ 80)
2. There is an increase in the class average score
3. Students' activity and activeness are in the good category

Based on the results obtained in Cycle II, the success indicators have been achieved; therefore, the action is declared successful.

Fourth, Interpretation of Results

The improvement in students' learning outcomes shows that the implementation of Straws media and number bags based on differentiated learning is effective in:

- Helping students understand arithmetic operation concepts
- Increasing students' activeness and learning motivation
- Accommodating differences in students' abilities

Thus, the use of concrete media combined with a differentiated learning approach has a positive impact on the quality of Mathematics learning in elementary schools.

RESULTS AND DISCUSSION

Cycle I (First Cycle)

a) Planning

1. Developing a Cycle I improvement module (1 meeting) in accordance with the learning implementation plan (lesson plan/module attached).
2. Preparing the concept of the material to be used as learning content.
3. Preparing research instruments to record and analyze data.
4. Preparing learning resources, materials, and supporting tools needed.
5. Preparing evaluation questions.

b) Action (Implementation)

1. Implementing actions in accordance with and referring to the learning scenario.
2. Students read the material provided in the learning module and teaching materials.
3. Students are expected to be active and creative.
4. Students are given an explanation of the material being studied.
5. Students are given assignments by the teacher/researcher.
6. This action is carried out in the classroom during the learning process.

c) Observation

1. Conducting observation from the beginning of learning when the teacher carries out apperception until the end of the lesson.

2. During the learning process, observations are made on students' activeness and interest.

d) Reflection

At this stage, the researcher analyzes all data or information collected from Cycle I. This analysis aims to determine whether the implementation of differentiated learning can improve students' mathematics learning outcomes. The success or failure of Cycle I becomes a reference for improvements in the next cycle.

Cycle II (Second Cycle)

a) Planning

1. Identifying problems that emerged in Cycle I and had not yet been resolved, and determining alternative solutions.
2. Determining learning achievement indicators.
3. Developing the Cycle II improvement module.
4. Preparing research instruments for data analysis.
5. Preparing learning strategies to improve students' learning outcomes.
6. Developing the Cycle II classroom action program.

b) Action (Implementation)

The implementation of the Cycle II classroom action program refers to the problems identified in Cycle I and is carried out according to the selected problem-solving alternatives, including:

1. The teacher conducts apperception.
2. Students are introduced to the learning material and the learning objectives to be achieved.
3. Reviewing mathematics learning material that was implemented in Cycle I using a differentiated learning approach through question and answer activities.
4. Concluding the lesson material.

c) Observation

1. Conducting observations based on the prepared observation sheet and recording all necessary events during the implementation of the action.
2. Assessing the results of the action based on the developed assessment format.

d) Reflection

At this stage, the researcher analyzes all data or information collected during Cycle II. If the problems experienced in the classroom are properly resolved, the classroom action research is considered successful and is stopped at Cycle II. The problem in this study is declared solved if the success indicators in Table 3.5 are met.

Table 5. Indicators of action achievement in this study, which are developed based on theories of active learning, learning motivation, learning outcomes, and the concept of differentiated learning.

No	Unqualified Learning	Qualified Learning
1	Learning does not sufficiently involve students' activeness	Learning is able to encourage students' activeness
2	Learning does not sufficiently foster students' interest in learning	Learning is able to increase students' interest in learning
3	Learning outcomes have not reached mastery (≥75%)	Learning outcomes reach mastery (≥75%/80%)
4	Interaction between students and teacher is still low	Active interaction occurs between students and teacher

The assessment instruments used in this study included a learning achievement test, observation sheets of students' activities, and the implementation of the learning module. In this study, there were two types of instruments, namely learning approach-based observation and tests (pretest and posttest). The learning approach was used to determine students' learning outcomes before and after the treatment using a differentiated learning approach.

This study was conducted in two cycles through the implementation of Straws learning media and number bags based on a differentiated learning approach for Grade I students at SDN Sidoarjo, consisting of 28 students. Based on the

evaluation results in each cycle, the following data were obtained:

Table 6. Result of learning outcomes

Cycle	Average Score	Number of Students Achieving Mastery	Mastery Percentage
Cycle I	76.25	13	46.43%
Cycle II	83.71	24	85.71%

Based on the table, it can be seen that there was an improvement in students' learning outcomes from Cycle I to Cycle II. In Cycle I, the mastery learning achievement had not yet reached the established success indicator, which was a minimum of 80%. However, in Cycle II, a significant improvement was observed, reaching 85.71%. The observation results showed that students' activities improved in each cycle, as indicated by:

- Students became more active in participating in learning activities
- Increased participation in group discussions
- Students showed greater enthusiasm in using learning media
- Increased confidence of students in asking and answering questions

Student Response Questionnaire Results

Based on the questionnaire results, most students gave positive responses toward the implemented learning, namely:

- Students felt that learning became more enjoyable
- Students found the material easier to understand
- Students felt more motivated in learning Mathematics
- The learning media helped them understand the concepts

The results of the study indicate that the implementation of Straws learning media and number bags based on a differentiated learning approach was able to significantly improve students' learning outcomes. This is shown by the increase in the average score from 76.25 in Cycle I to 83.71 in Cycle II, as well as the increase in mastery learning from 46.43% to 85.71%. This achievement has exceeded the success indicator set at ≥ 80% of students reaching the Minimum Mastery Criteria (KKM).

Compared with previous studies, these findings reinforce research stating that the use of concrete media can improve elementary students' understanding of mathematical concepts. However, most previous studies tend to focus only on the effectiveness of learning media without integrating adaptive learning approaches that accommodate individual differences among students. In this study, the improvement in learning outcomes is not only caused by the use of concrete media but also by the implementation of differentiated learning, which allows the adjustment of learning strategies based on students' needs, abilities, and characteristics.

In addition, previous studies on differentiated learning generally focus on increasing student engagement and motivation but have not specifically linked it with the use of simple manipulatives in basic mathematics learning contexts. In contrast, this study shows that the integration of concrete media and differentiated learning provides a more comprehensive impact, not only on cognitive aspects (learning outcomes) but also on affective and social aspects of students.

From a more critical perspective, the improvement in Cycle II does not only indicate the success of the intervention but also reflects students' adaptation to the implemented learning model. In Cycle I, students were still in the adjustment phase regarding the use of learning media and different instructional patterns. This resulted in suboptimal outcomes. However, in Cycle II, students became more familiar with the use of Straws and number bags and better understood the differentiated learning approach, leading to a significant improvement in learning outcomes.

From the perspective of cognitive development theory, these findings are

consistent with the view that elementary school students are at the concrete operational stage, where the use of manipulatives is highly effective in helping them understand abstract concepts. However, this study also shows that the use of concrete media alone is not sufficient without a learning strategy that accommodates individual differences. Therefore, differentiated learning becomes a key factor that strengthens the effectiveness of such media.

Nevertheless, this study also has limitations. First, it was conducted in only two cycles with a limited number of participants, so the generalization of the findings should be interpreted with caution. Second, the study has not deeply examined the influence of each component of differentiation (content, process, product) on students' learning outcomes. Third, the simplicity of the learning media requires teacher creativity in managing it to remain effective in the long term.

Thus, it can be critically concluded that the main strength of this study lies in the integration of concrete learning media and differentiated learning approaches, which has proven to be more effective than using either approach separately. These findings contribute to the development of mathematics learning strategies in elementary schools, particularly in the context of the *Merdeka Curriculum*, which emphasizes student-centered and adaptive learning to accommodate diverse abilities.

CONCLUSION AND SUGGESTIONS

Based on the Classroom Action Research that has been conducted, it can be concluded that the implementation of Straws learning media and number bags integrated with a differentiated learning approach is proven to be effective in improving the mathematics learning outcomes of Grade I elementary school students. This is indicated by a significant increase in the class average score from 76.25 in Cycle I to 83.71 in Cycle II, as well as an increase in the mastery learning percentage from 46.43% to 85.71%, which has exceeded the predetermined success indicator.

In addition, the implementation of the action also had a positive impact on improving students' activeness, motivation, and engagement in the learning process. Students became more able to understand the concepts of addition and subtraction in a concrete way and showed improvement in independent problem-solving skills.

Thus, the integration of concrete learning media with a differentiated learning approach not only improves cognitive learning outcomes but also contributes to the development of students' affective and social aspects.

These findings emphasize the importance of integrating concrete media with differentiated learning in improving Mathematics learning outcomes. Therefore, teachers need to design learning that is adaptive to student diversity. Schools are expected to support this through strengthening teacher capacity and providing relevant learning resources. Future research is encouraged to expand the context and research design to test effectiveness in a more generalizable manner, including integrating digital technology. Furthermore, the results of this study can serve as a basis for developing more inclusive and student-centered learning policies.

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