Education Mind

EDUCATION MIND
2024, VOL 3, NO 1, 73-80
DOI: 10.58583/Pedapub.EM2407

Research Article

Open Access

Dienes block media assisted by mathematical worksheets to improve student learning outcomes: Teacher action research

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ARTICLE HISTORY

Received: 23.02.2024
Accepted: 10.05.2024

KEYWORDS

Dienes block
Mathematical worksheet
Teacher action research
Word problems

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ABSTRACT

The development of science has shifted the process of learning mathematics from previously only involving numbers to numbers that have meaning, one of which is in the form of stories. However, many problems still need to be solved with the concept of addition and subtraction in the form of story problems. This research aims to improve student learning outcomes in addition and subtraction material through story problems. This research used the Teacher Action Research (TAR) approach with 14 second-grade students at Ciren Elementary School, Indonesia as participants. This research also used two data collection methods: providing mathematical worksheets and observations carried out by special observers. Data analysis was carried out by looking at the mean student scores, reflecting through FGDs with observers, and filling in observation sheets by the teacher. Furthermore, the results of this research are presented in the form of teacher observation sheet scores and mathematical worksheet work results. The score results on the observation sheet show an increase in scores from learning in cycle 1 to cycle 2. In addition, the average score of students' mathematical worksheets after intervention in the form of dienes block media and mathematical worksheets always increases with pre-cycle details (48), cycle I (80), and cycle II (84). Thus, using dienes block media assisted by mathematical worksheets can have direct implications for improving mathematics learning in addition and subtraction operation material.

Introduction

Mathematics is one of the main subjects in elementary school (Brumbaugh et al., 2005). The development of science has shifted the mathematics learning process from previously only involving numbers to numbers with meaning or context (Ma, 2010). One way to measure students' understanding of the meaning of a number is by giving questions in story form (Burr et al., 2021). In mathematical story problems, students or problem solvers are asked to apply their mathematical knowledge to solve problems described in the context of story situations.

Mathematics story problems are designed to develop students' understanding of mathematical concepts, promote analytical thinking, and hone their problem-solving abilities (Schley & Fujita, 2014). Often, math story problems create a real-world context for students to identify practical applications of math concepts in everyday life. In this way, students can see the relevance and usefulness of mathematics outside the classroom environment (Bilsky et al., 1986). Some math word problems involve basic arithmetic operations such as addition, subtraction, multiplication, and division, while others involve concepts such as comparison, ratio, percentage, area, perimeter, and so on (Wangid et al., 2021).

In the elementary school levels in lower grades (grades 1-3), the mathematical content in word problems is still within the scope of addition and subtraction operations (Saparuddin et al., 2022). Addition and subtraction are two basic mathematical concepts taught in elementary school. These two concepts form the basis for understanding more complex mathematical concepts at later levels (McKenzie & Thompson, 1973). It is essential to teach students in elementary school these two concepts through accurate and contextual approaches (story problems), such as using physical objects or pictures to help them understand the concepts of addition and subtraction (Briars & Larkin, 1984; Griffin et al., 2018).

However, there are still many problems related to addition and subtraction in the form of story problems—results of interviews with second-grade teachers at Ciren Public Elementary School online via the Zoom platform. The problem experienced by second-grade teachers at Ciren Public Elementary School was related to students' ability to understand addition and subtraction word problems. Students find it difficult to understand sentences with the keywords "More than," "Less than," and "More," which are commonly used in problem sentences. According to the teacher, this problem occurs because students are not used to reading math problems with sentences. Students usually immediately look at the numbers in the question without reading the question sentence first.

Responding to the findings of this problem, the researchers assumed that he could solve the problem using dienes block media with the help of Student Mathematical Worksheets. Dienes blocks are a mathematical tool used in learning basic mathematical concepts, significantly to help students understand arithmetic operations such as addition, subtraction, multiplication, and division (Manek, 2023). Dienes block media effectively provides visual and concrete images of mathematical concepts (Dami, 2023). Each block size has a specific numerical value, and students can combine or separate these blocks to model mathematical operations. This media is very appropriate as a starting point for addition and subtraction operations following the concept of place value (de Walle et al., 2016). Addition and subtraction operations corresponding to place value can help students more easily carry out abstractions in operating numbers without writing (scrounging).

To optimize this media, researchers will accompany the dienes block media with Mathematical Worksheets. Mathematical Worksheets will help teachers carry out learning sequentially and according to the plan that has been given. Mathematical Worksheets can also be a place for students to write down the results of calculations using the dienes block media given to students. According to Septian et al. (2019), Mathematical Worksheets help students understand learning material better. Mathematical Worksheets guide students through specific steps or concepts by presenting information in a structured format. Apart from that, according to Gustin et al. (2020), Mathematical Worksheets can be used as an independent practice carried out by students in class or as homework. This allows students to respond to learning material independently and hone their work skills.

Based on the research results described above, teacher block media and Mathematical Worksheets are used separately or not integrated. In this research, the Mathematical Worksheets prepared have been integrated with student activities using dienes block media. Researchers will elaborate on the positive aspects of these two learning tools in one mathematics activity. The combination of dienes block media and Mathematical Worksheets is intended to optimize addition and subtraction activities carried out by students in class. This is following the aim of this research, namely, to improve student learning outcomes in addition and subtraction material in the form of story problems.

Method

Research design

This research uses the qualitative with Teacher Action Research (TAR) approach. The TAR approach is a research design carried out by teachers to improve the learning process in the classroom (Bell & Aldrigde, 2014). The TAR approach allows teachers to improve student learning outcomes, improve the quality of learning activities, and measure the success of interventions designed and implemented by teachers in the classroom (Reeves, 2008). This approach consists of four main stages, namely:

Step 1. Assessing the learning environment

Researchers measure student learning outcomes at this stage before the intervention is given. In this case, the teacher uses data on students' previous mathematics learning outcomes as a reference (pre-cycle) in determining the intervention to be provided. Teachers observe student behavior in previous lessons to design interventions according to student needs. The result of this stage was that student learning outcomes were still low in addition and subtraction material in the form of story problems.

Step 2. Reflection and discussion

Data on students' previous mathematics learning outcomes and observation notes are used by teachers in determining the interventions to be carried out. Researchers used the focus group discussion (FGD) method with lecturers and doctoral students to design appropriate learning interventions. This activity is carried out online using the Zoom platform. The result of this FGD activity is that the Dienes Block media, assisted by Mathematical Worksheets, can improve student learning outcomes in addition and subtraction material in the form of story problems.

Step 3. Intervention

At this stage, researchers begin to plan, implement, and monitor the interventions provided in the classroom. This intervention activity is carried out in several cycles depending on student needs. The learning cycle model in this research was developed from Kemmis in Bell & Aldrigde (2014) which can be seen in Figure 1 below.

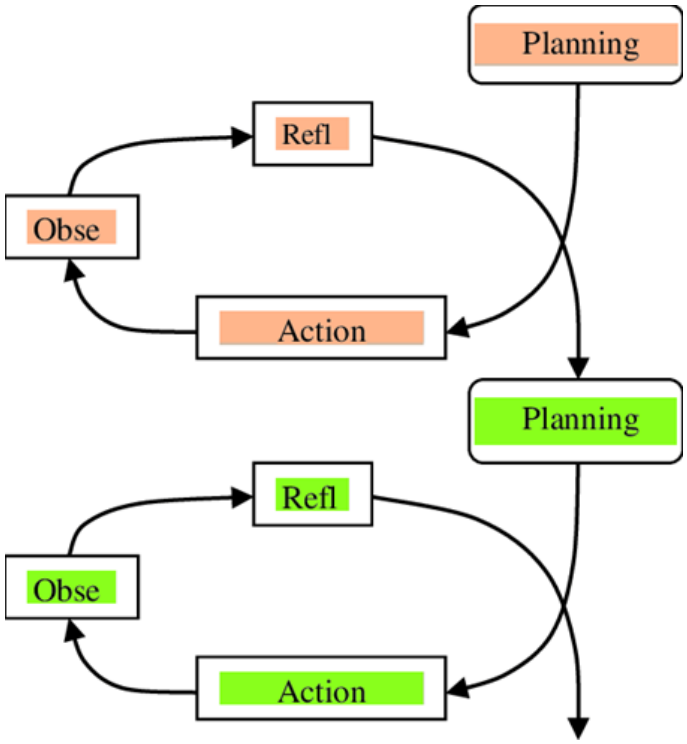

Figure 1 Kemmis's learning cycle in research

Step 4. Re-assessment

The final stage is to carry out a final assessment to measure student learning outcomes in addition and subtraction material in the form of story problems. Student grades are seen from the results of filling in the Mathematical Worksheets carried out by students in learning cycle 2. Information on changes in student grades from the initial assessment to the final assessment becomes a reference for researchers to stop the cycle and declare the success of the intervention in classroom learning.

Participants and location

The participants involved in this research were 14 second grade students at Ciren Public Elementary School. Ciren Public Elementary School is located at Ciren, Triharjo, Kec. Pandak, Bantul Regency, Special Region of Yogyakarta. The participants involved consisted of 8 female students and 6 male students. As for the age of the participants, 9 students were 7 years old (Normal Age in Indonesia), while the remaining 5 were 8 years old.

Data collection

This research uses two data collection methods, namely providing Mathematical Worksheets and observations carried out by two special observers (lecturers/doctoral students) other than teachers. Mathematical Worksheets measure the success of mathematics learning outcomes in addition and subtraction material in the form of story problems. Meanwhile, observation sheets are used to view the learning process in the classroom and observe student behavior that occurs when the intervention is carried out.

Data analysis

Data analysis was carried out by looking at classical completion criteria and the mean or average score produced by students after the intervention was given (Nanda et al., 2021). The classical completeness criteria used are ⩾70% of students scoring >70. Researchers also reflect through FGD activities with observers improve interventions in the next cycle. The observation sheet also

has a score to see improvements in the teacher's learning process. Teachers are also asked to fill out an observation sheet form so that data can be cross sectioned during the reflection process. This is done to maintain the validity and reliability of data collected in the field.

Results and discussions

The score given on the observation sheet with the maximum score is 48. The results of observations made on learning carried out in cycle 1 and cycle 2 can be seen in Figure 2 below:

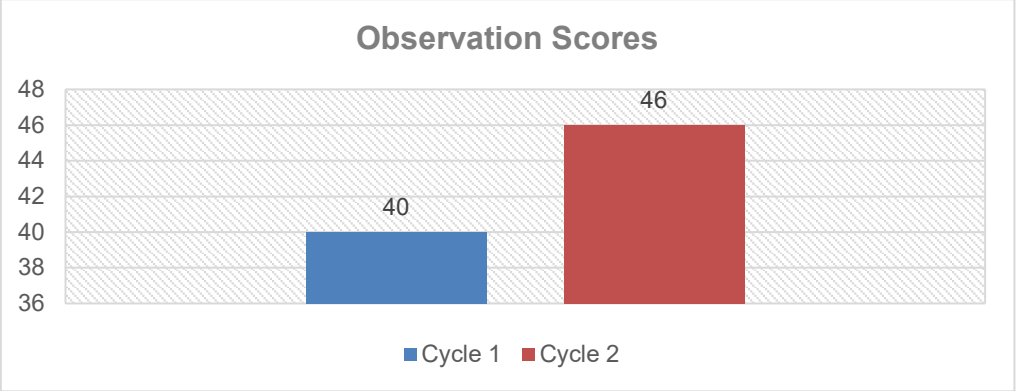

Figure 2 Teacher observation sheet score results

The score results on the observation sheet show an increase in scores from learning in cycle 1 to cycle 2. This shows that there has been an improvement in teacher learning carried out in cycle two after reflecting on learning in cycle 1. The first improvement is the grouping process, which is no longer done sequentially. Random, but chosen based on student ability. The group members initially had five students, but this was reduced to a maximum of 4 students per group. Apart from this, there are changes to the Mathematical Worksheets completion system, giving each activity a time limit. The impact of these three changes is that students become more active in completing the Mathematical Worksheets. All students are involved in completing the Mathematical Worksheets and try to complete them according to the time given. The work process becomes more efficient, and the discussion process between students becomes more active.

Apart from the results of this observation sheet, the researchers also corrected the results of students' work on the Mathematical Worksheets. The teacher and observer (lecturer/doctoral student) correct the results of student work simultaneously after the learning process is complete. Data on student scores from pre-cycle, cycle 1, to cycle 2 can be seen in figure 3 below:

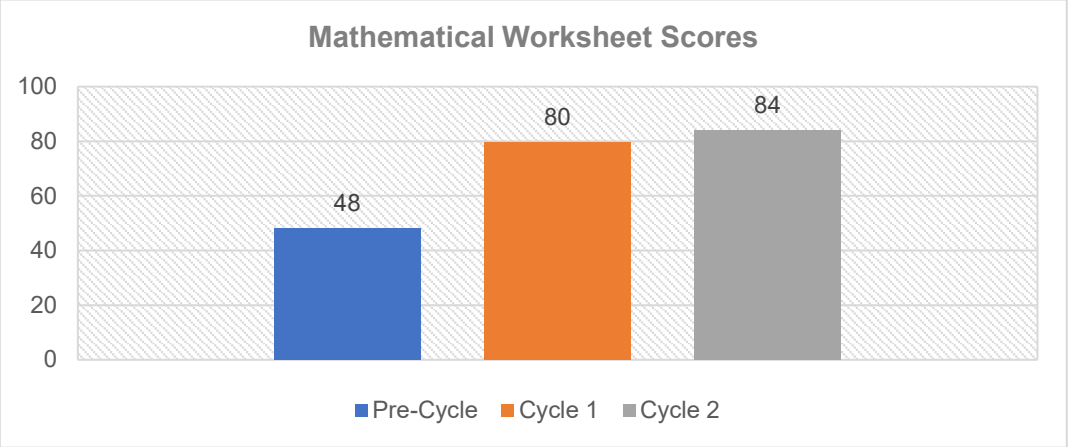

Figure 3 Scores of Student Mathematical Worksheet

Figure 3 shows that the average student's Mathematical Worksheets score increases with each lesson. The average student pre-cycle score was 48, while in cycle 1, the average rose to 80. After the intervention improvements, the average student score rose to 84. The students' classical completion criteria at the end of cycle two also reached 100%, or all students scored >70. This shows that intervention in dienes block media and Mathematical Worksheets can improve student learning outcomes in addition and subtraction material through story problems.

These findings are consistent with previous research conducted by Isnaniah & Imamuddin (2020) which also found a significant increase in student scores after implementing the intervention. Previous research conducted by Sarama & Clements (2009) concluded that the use of dienes block media and Mathematics Worksheets improved students' understanding of addition and subtraction material. Our results are in line with their findings, indicating that the intervention was effective in improving students' learning outcomes through story problems.

However, it should be noted that there are some differences in study design between our study and previous studies. Isnaniah & Imamuddin (2020); Safi & Desai (2017) used an experimental design with a control group, while we used a single intervention design without a control group. In addition, the duration of the intervention and the evaluation instruments used may also differ between the studies. Nevertheless, overall, our findings support and complement previous research in demonstrating the effectiveness of using dienes block media and Mathematics Worksheets in improving student learning outcomes in mathematics.

The research results show that the Dienes block media and Mathematical Worksheets can improve student learning outcomes in addition and subtraction material in story problems. In line with this, research results from Irpan (2012) show that dienes blocks are an effective teaching tool for understanding students about the concept of place value. In the book "Elementary and Middle School Mathematics: Teaching Developmentally" by de Walle et al. (2016), addition and subtraction operations should start from understanding place value. Using place value concepts in addition and subtraction operations is perfect for training students' ability to perform calculations abstractly (in their minds without writing them down).

The results of other research from Dami et al. (2023) and Safitri et al. (2018) show that using Dienes Block media effectively improves students' addition and subtraction abilities. This is because the form of media, a hands-on activity, allows students to operate the media used directly. Observation results also show that student participation in class significantly increases when mathematics activities using dienes blocks are carried out. This follows Hochberg's (2010) theory that elementary school students tend to like concrete activities compared to abstract activities.

The use of Mathematical Worksheets to accompany the Dienes Block also trains students' abilities in mathematical literacy. This type of Mathematical Worksheet is designed with lots of sentences and context close to the students, indirectly making students read the narrative in the Mathematical Worksheets. According to Bilsky et al. (1986), appropriate mathematical context is the key to successfully increasing students' mathematical abilities. Contexts that students can imagine directly are a form of scaffolding that teachers provide to make it easier for students to solve problems in the form of story problems (Griffin et al., 2018). The development of mathematics assessments in the form of story questions requires students to have good mathematical literacy (numeracy) skills. The Mathematical Worksheets used in class have been proven to improve students' mathematical literacy skills, as indicated by increased student learning outcomes in addition and subtraction material in the form of story problems.

Conclusion

Based on data analysis of learning outcomes and results of learning observation sheets in two cycles, it can be concluded that:

1. Learning using dienes block media with the help of Mathematical Worksheets has a positive impact in improving students' mathematics learning outcomes in addition and subtraction material in the form of story problems, which is marked by an increase in students' average scores in each cycle, namely pre-cycle (48), cycle I (80), cycle II (84). The percentage of completeness in class also increases with each cycle, namely pre-cycle (56%), cycle I (82%), and cycle II (100%).
2. Learning using dienes block media assisted by Mathematical Worksheets has a positive influence; it can increase student learning participation. This is shown from the results of observations made during the learning process.

The results of this research can have direct implications for improving mathematics learning in the classroom. Learning design using dienes block media assisted by Mathematical Worksheets has been proven to improve second-grade student learning outcomes on addition and subtraction operations. These findings can be a reference for teachers to design learning in their respective classes. These findings can also be followed up in experimental trial research to see the statistical effect of Mathematical Worksheet-assisted dienes block media.

Acknowledgement

We would like to thank the Ministry of Education, Culture, Research, and Technology as the main funding for the research we conducted. We also thank all parties involved in this research, namely Yogyakarta State University, UNY Center for Excellence in Literacy and Numeracy (PULITNUM), and Ciren Public Elementary School who have supported the research and publication process in this research.

Disclosure statement

No potential conflict of interest was reported by the author(s).

References

Bell, Lisa. M., & Aldrigde, Jill. M. (2014). *Student Voice, Teacher Action Research and Classroom Improvement* (Barry J. Fraser, Ed.; 1st ed., Vol. 6). Sense Publishers.

Bilsky, L. H., Blachman, S., Chi, C., Chan Mui, A., & Winter, P. (1986). Comprehension Strategies in Math Problem and Story Contexts. *Cognition and Instruction*, 3(2), 109–126. https://doi.org/10.1207/s1532690xci0302_2

Briars, D. J., & Larkin, J. H. (1984). An Integrated Model of Skill in Solving Elementary Word Problems. *Cognition and Instruction*, 1(3), 245–296. https://doi.org/10.1207/s1532690xci0103_1

Brumbaugh, D. K., Moch, P. L., & Wilkinson, M. (2005). *Mathematics Content for Elementary Teachers* (1st ed.). Lawrence Erlbaum Associates.

Dami, J. (2023). Penggunaan Blok Dienes Dalam Pembelajaran Perkalian Bersusun Untuk Meningkatkan Hasil Belajar Siswa Kelas IV SDI KUANINO 3 [Use of Dienes Blocks in Learning Multiplication to Improve Class IV Student Learning Results at SDI KUANINO 3]. *Journal of Character and Elementary Education*, 1(3), 1–6. https://doi.org/10.35508/jocee.v1i3.11288

de Walle, J. A. Van, Karp, K. S., & Bay-Williams, J. M. (2016). *Elementary and middle school mathematics: teaching developmentally* (9th ed.). Pearson Education Limited.

Di Lonardo Burr, S. M., Turner, J., Nietmann, J., & LeFevre, J.-A. (2021). When does the story matter? No evidence for the foregrounding hypothesis in math story problems. *Journal of Numerical Cognition*, 7(3), 259–274. https://doi.org/10.5964/jnc.6053

Griffin, C. C., Gagnon, J. C., Jossi, M. H., Ulrich, T. G., & Myers, J. A. (2018). Priming Mathematics Word Problem Structures in a Rural Elementary Classroom. Rural *Special Education Quarterly*, 37(3), 150–163. https://doi.org/10.1177/8756870518772164

Gustin, L., Sari, M., Putri, R., & Putra, A. (2020). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Realistic Mathematic Education (RME) pada Materi Persamaan dan Pertidaksamaan Linear Satu Variabel [Development of Student Worksheets (LKPD) Based on Realistic Mathematic Education (RME) on One Variable Linear Equations and Inequalities]. *Mathline: Jurnal Matematika Dan Pendidikan Matematika [Mathline: Journal of Mathematics and Mathematics Education]*, 5(2), 111–127. https://doi.org/10.31943/mathline.v5i2.154

Hochberg. (2010). *Educational Psychoogy Theory and Practice* (1st ed.). Pearson.

Irpan, S. (2012). Dienes' Multiple Embodiments and The Sequence of Instruction (Sajian Materi Dan Urutan Instruksi Dari Teori Dienes). *Beta Journal*, 5(2), 108–123. http://jurnalbeta.ac.id

Isnaniah, & Imamuddin, M. (2020). Students' Understanding of Mathematical Concepts Using Manipulative Learning Media in Elementary Schools. *Journal of Physics: Conference Series*, 1471(1), 012050. https://doi.org/10.1088/1742-6596/1471/1/012050

Ma, L. (2010). *Knowing and Teaching Elementary Mathematics*. Lawrence Erlbaum Associates.

Manek, H. (2023). Peningkatan Hasil Belajar Matematika Siswa Dengan Menggunakan Media Blok Dienes Pada Materi Operasi Penjumlahan Bilangan Cacah [Improving Student Mathematics Learning Outcomes Using Dienes Block Media in Whole Number Addition Operation Material]. *Fraktal: Jurnal Matematika Dan Pendidikan Matematika [Fractals: Journal of Mathematics and Mathematics Education]*, 4(1), 1–11. https://doi.org/10.35508/fractal.v4i1.10368

McKenzie, R., & Thompson, R. J. (1973). *An Elementary Construction of Unsolvable Word Problems in Group Theory* (pp. 457–478). https://doi.org/10.1016/S0049-237X(08)71914-1

Nanda, I., Sayfullah, H., Pohan, R., Suci Windariyah, D., Mulasi, S., Warlizasusi, J., Uron Hurit, R., Arianto, D., Wahab, A., Nur Aini, A., Dewa Gede Alit Rai Bawa, I., & Hadi Prasetyo, A. (2021). Penelitian Tindakan Kelas Untuk Guru Inspiratif [Classroom Action Research for Inspirational Teachers] (M. Pd. I. Dr. Adirasa Hadi Prasetyo, Ed.; 1st ed.). CV. Adanu Abimata. https://penerbitadab.id

Reeves, Douglas. B. (2008). *Reframing Teacher Leadership to Improve Your School* (1st ed.). Association for Supervision and Curriculum Development.

Safi, F., & Desai, S. (2017). Promoting Mathematical Connections Using Three-Dimensional Manipulatives. *NCTM*, 22(8), 101–111.

Sarama, J., & Clements, D. H. (2009). "'Concrete'" Computer Manipulatives in Mathematics Education. *Child Development Perspectives*, 3(3), 145–150.

Safitri, N., Pendidikan, J., & Biasa, L. (2018). Efektivitas Media Balok Dienes Terhadap Kemampuan Penjumlahan Dalam Pembelajaran Matematika Untuk Anak Slow Learner Kelas II di SDN GEJAYAN. *Jurnal Widia Ortodidaktika*, 7(3), 238.

Saparuddin Nur, A., Kartono, K., Zaenuri, Z., & Rochmad, R. (2022). The Learning Trajectory Construction of Elementary School Students in Solving Integer Word Problems. *Participatory Educational Research*, 9(1), 404–424. https://doi.org/10.17275/per.22.22.9.1

Schley, D. R., & Fujita, K. (2014). Seeing the Math in the Story. *Social Psychological and Personality Science*, 5(8), 953–961. https://doi.org/10.1177/1948550614539519

Septian, R., Irianto, S., & Andriani, A. (2019). Pengembangan Lembar Kerja Peserta Didik (Lkpd) Matematika Berbasis Model Realistic Mathematics Education. *Jurnal Educatio FKIP UNMA*, 5(1), 59–67.

Wangid, M. N., Putra, C. A., & Rudyanto, H. E. (2021). The Science-Math Stories Based on Digital Learning: Digital Literacy Innovation in Increasing Ability to Solve Problems. *International Journal of Emerging Technologies in Learning (IJET)*, 16(09), 94. https://doi.org/10.3991/ijet.v16i09.22039