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Improving primary school students' multiplication ability using "smart suitcase" media assisted by mathematical worksheets

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ABSTRACT

In mathematics, there are four basic operations that students must master from the elementary school level, namely addition, subtraction, multiplication, and division. However, some students experience difficulties or misunderstandings in interpreting multiplication as repeated addition. This research aims to improve the learning outcomes of second-grade students on multiplication material in elementary schools. This research used the teacher action research approach with 20 second-grade students at Kepuhan Sewon Public Elementary School as participants. Apart from that, this research used two data collection methods, namely providing mathematical worksheets and observations carried out by special observers. Data analysis was carried out by looking at the students' average scores, reflecting through focus group discussions 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 worksheets 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 smart suitcase media and mathematical worksheets always increases with pre-cycle details (82), cycle I (93), and cycle II (94). Thus, the use of smart suitcase media assisted by mathematical worksheets has direct implications for improving the learning outcomes of second-grade students in the material of multiplication of integers.

Keywords: mathematical worksheets, smart suitcase, teacher action research

INTRODUCTION

In mathematics, there are four basic operations that students must master, namely addition, subtraction, multiplication, and division (Brumbaugh et al., 2005). Students must master these four operations from the elementary school level. One operation that quite often causes problems for students is the multiplication operation (Tillema, 2013). The multiplication process involves multiplying two or more numbers to get the result (Kosko, 2019). During elementary school learning, students will hone their multiplication skills through exercises, problem-solving, and understanding basic mathematical concepts.

Although multiplication is one of the basic concepts in mathematics taught in elementary schools, some students may experience some difficulties or misunderstandings in understanding it (Wong & Evans, 2007). Some common problems associated with multiplication in elementary schools are, as follows:

(1) Students may have difficulty understanding the concept that multiplication involves repeating a certain amount of one number (the multiplier) as many times as another number (the factor). This understanding can be key to understanding the significance of the multiplication operation (Lo et al., 2008).

(2) Calculation errors may occur due to a lack of focus or poor understanding of the concept of multiplication. These errors can occur in multiplying larger numbers or when students try to remember multiplication facts (Putri et al., 2023).

(3) Some students may face difficulties in applying the concept of multiplication in solving mathematical problems. This involves the ability to identify relevant information, formulate equations, and calculate multiplication results (Ilukena et al., 2020).

This problem is also in line with the findings of a preliminary study conducted by researchers at Kepuhan, Bantul Public Elementary School, Yogyakarta. Based on the results of interviews with second-grade teachers, it was found that the multiplication problem experienced by students was students' difficulty in interpreting multiplication as repeated addition. Apart from that,

teachers also experience misconceptions about the concept of multiplication, because they cannot differentiate between the multiplication operations "3×4" and "4×3". The teacher considers the multiplication operation "3×4" to be "3+3+3+3" even though the correct concept is "4+4+4".

Responding to problems found in the field, researchers assume that to improve the multiplication learning outcomes of second-grade students to use hands-on activity media that can be operated directly by students. Hands-on activity media, or direct practice activities, is a learning approach that actively involves students in physical or interactive activities to understand certain concepts (Kanastren et al., 2023). The use of hands-on activity media not only increases understanding of concepts but also helps students develop critical skills such as problem-solving, teamwork, and creative thinking (Isnaniah & Imamuddin, 2020). In addition, involving students directly in learning can make learning more interesting and relevant for them (Perbowo et al., 2019). The form of hands-on activity media designed by researchers is smart suitcase media. This media will generally explain the multiplication process because of repeated addition.

To optimize the use of this media, researchers used mathematical worksheets to ensure that the mathematics activities carried out by students in class were directed and coherent. Mathematics worksheets are a learning tool commonly used in elementary schools to help students practice and master mathematical concepts (Supriyanto et al., 2020). Its use has several purposes and benefits, including the followings:

(1) Providing students with practice to deepen their understanding of the mathematical concepts taught in class. It includes basic mathematical operations, problem-solving, and concept application (Suherman et al., 2021).

(2) Provides tools for assessing student progress. Teachers can use the results of work on worksheets as a guide to assess the extent to which students understand and master the learning material (Fahmasari & Darmawijoyo, 2020).

(3) Provide problem-solving questions that involve the application of mathematical concepts in real contexts. This helps students develop their problem-solving abilities (Sari et al., 2023).

The results of the implementation of the use of hands-on activity media have been carried out several times. The research results of Safi and Desai (2017) and Sarama and Clements (2009) found that the use of hands-on activity media can contribute to increasing students' understanding of mathematical concepts. Students can more easily understand abstract ideas through physical representations. Apart from that, the research results of Perbowo et al. (2019) found that hands-on activity media can increase student involvement in learning. Hands-on activities can make learning more interesting and relevant for students, helping them become actively involved in the learning process. Another finding from Kanastren et al. (2023) and Mcleod (2013) also found that hands-on activity media can provide support for students with various learning styles. Students have different learning preferences, and manipulatives provide concrete ways for visual, auditory, and kinesthetic students to understand concepts.

Different from previous studies, this research will elaborate on a hands-on activity media called "smart suitcase" with mathematical worksheets for learning mathematics on multiplication material. Previous research only used media without being accompanied by a comprehensive mathematical worksheets. It is hoped that the existence of this mathematical worksheets can ensure that students are more structured and understand the steps for using media well. ***This is following the aim of this research is to improve the learning outcomes of second-grade students on multiplication material in elementary schools***.

METHOD

Research Design

This research uses teacher action research (TAR) approach. TAR approach is a research design carried out by teachers to improve the learning process in the classroom (Bell & Aldrigde, 2014). 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 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 & 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 smart suitcase media assisted by mathematical worksheets to improve student learning outcomes in integer multiplication material.

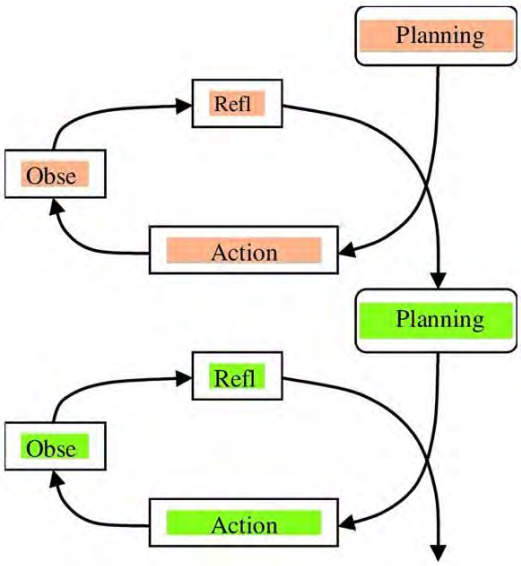

Figure 1. Kemmis's learning cycle in research (Bell & Aldrigde, 2014)

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 and Aldrigde (2014), which can be seen in **Figure 1**.

Step 4. Re-assessment

The final stage is to carry out a final assessment to measure student learning outcomes in integer multiplication material. Student grades are seen from the results of students completing the mathematical worksheets 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.

Participant & Location

The participants involved in this research were 20 second-grade students at Kepuhan Sewon Public Elementary School. The school is located at Jl. Semail, Kepuhan, Timbulharjo, District Sewon, Bantul Regency, Special Region of Yogyakarta.

Data Collection

This research uses two data collection methods, namely providing mathematical worksheets and observations carried out by special observers (lecturers/doctoral students) other than teachers. In addition, we use smart suitcase media for learning process.

Mathematical worksheet

Mathematical worksheets is used to measure the success of mathematics learning outcomes in integer multiplication material. Mathematical worksheets are given to students four times for learning in two cycles. In one cycle, we use two mathematical worksheets to assess one assessment. The mathematical worksheets at the first meeting contained repeated addition activities, followed by the second meeting by changing the concept of repeated addition to the concept of multiplication. At the third meeting, students were invited to practice multiplication questions, and this was strengthened by the fourth meeting, where students were invited to solve the questions in the form of problem-solving. This instrument has been tested for content validity by experts and declared suitable for use in data collection.

Obseervation

Meanwhile, observation sheets are used to view the learning process carried out in the classroom, as well as observe student behavior that occurs when the intervention is carried out. For greater clarity, **Table 1** shows the indicators for observations made by researchers.

This observation is carried out during the learning process by a special observer outside the teacher. After the learning process, the observer will reflect on the results of the observation with the teacher to improve further learning. This instrument has been tested for content validity by experts and declared suitable for use in data collection.

Smart suitcase media

The learning media used in this research is a smart suitcase. This media contains the activity of moving a ball carried out by students in a suitcase. The movement of the ball is a marker for increasing or decreasing the ball according to the counting operation carried out. This activity can help students understand the concept of multiplication of whole numbers.

Table 1. Learning observation indicators

No	Aspect	Indicators
1	Activities in student & milieu interaction	Students do learning in groups.
		Students carry out the instructions in the mathematical worksheets.
		Students can work on mathematical worksheets freely (high student mobility).
		Students actively collaborate with friends in one group to complete the mathematical worksheets.
		Students are able to interpret the mathematical context in the mathematical worksheets.
		Students are able to solve the problems given on the mathematical worksheets.
		Students communicate with each other in groups when completing mathematical worksheets.
		All group members are involved in completing the mathematical worksheets.
2	Activities in student & milieu interaction	The teacher provides instructions in accordance with the mathematical worksheets.
		The teacher becomes a learning facilitator.
		Teachers are able to provide scaffolding according to student needs.
		The teacher is able to provide scaffolding according to correct mathematical concepts.
		Teachers provide feedback to students.
		The teacher provides reinforcement to students after completing the mathematical worksheets.
3	Classroom management	Ability to master the class/class management.
		Do the learning due to the planned time allocation.

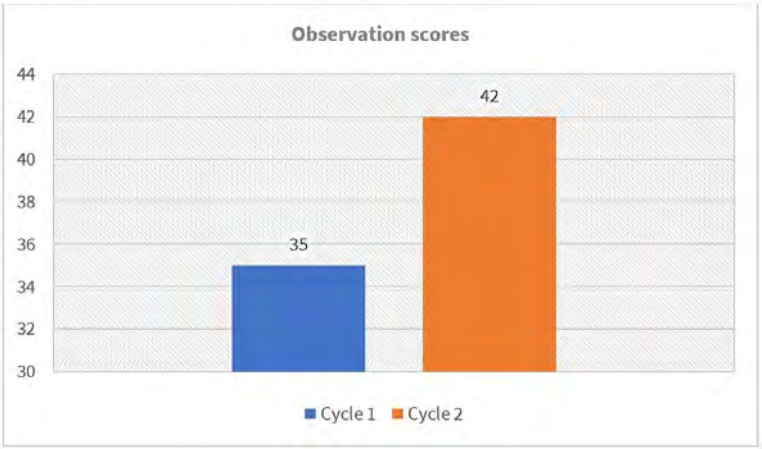

Figure 2. Teacher observation sheet score results (Source: Authors' own elaboration)

Data Analysis

Data analysis was carried out by looking at classical completion criteria by looking at 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 getting a score >70. Apart from that, researchers also reflect through FGD activities with observers (lecturers/doctoral students) to improve interventions in the next cycle. The observation sheet also has a score to see improvements in the learning process carried out by the teacher. 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 of data collected in the field.

RESULTS & DISCUSSION

Results

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**.

The score results on the observation sheet show an increase in scores from learning in cycle 1 to cycle 2. This shows that there are improvements in teacher learning carried out in cycle 2 after reflection on learning in cycle 1. The results of improvements in the implementation of learning from cycle 1, caused several changes that occurred in cycle 2. Implementation of learning in cycle 2 was active. Even though student involvement in the process of completing the mathematical worksheets is still not running optimally, it is better than the student activity at the first meeting.

In cycle 2, it was also found that several students did not fill in the mathematical worksheets completely because there was no "..." sign, which caused students to think that this form did not need to be filled in. The teacher provides appropriate scaffolding, as well as several trigger questions to make students more active in the process of completing the mathematical worksheets. Teachers also often provide feedback to students who ask questions. At the end of the lesson, the teacher also provides reinforcement that is by the multiplication concept learned at this second meeting. However, teachers need to increase and refine students' informal knowledge in didactic activities.

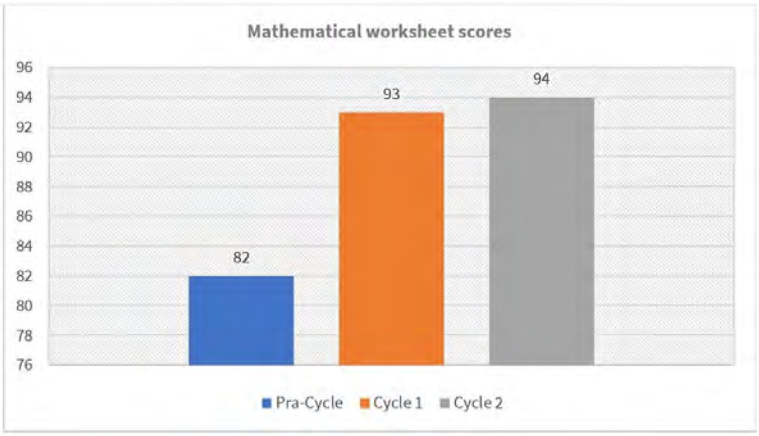

Figure 3. Scores of student mathematical worksheet (Source: Authors' own elaboration)

Table 2. Learning improvements

No	Before reflection	After reflection
1	Grouping is carried out randomly without considering student's character.	Students are grouped on student character. This causes group situation to become more active because students work together to complete LKPD.
2	There is no time limit for filling out LKPD.	Students are given a time limit for completing each activity. This causes students to be more motivated to complete LKPD. Because they are motivated, students are more active in asking questions, giving opinions, & communicating with friends in group.
3	Number of student members in group is between five or more.	Students are grouped with a maximum of four students. This causes student involvement in group to be more even, & each student contributes to completing LKPD given.
4	There are too many interventions provided by teachers.	Teachers minimize providing intervention. This makes students more independent in adidactical process when completing given LKPD.
5	Several errors in symbols & instructions on LKPD.	Check LKPD again & revise LKPD so that there are no symbol errors before next teaching experiment is carried out.

Apart from the results of this observation sheet, the researcher 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**.

Figure 3 shows that the student's mathematical worksheets score increases with each lesson. The average student pre-cycle score was 82, while in cycle 1 the average began to rise to 93. After the intervention improvements, the average student score rose to 94. The students' classical completion criteria at the end of cycle 2 had also reached 100% or all students have scored >70. This shows that intervention in the form of smart suitcase media and mathematical worksheets can improve student learning outcomes in integer multiplication material.

Learning reflection is carried out at the end of each teaching experiment between teachers, undergraduate students, and doctoral students. The reflection material is documentation and the results of filling in the observation sheet. In general, reflections on improvements to the teaching experiment can be seen in **Table 2**.

Discussion

The results of the research show that smart suitcase media assisted by mathematical worksheets can improve student learning outcomes in the material of multiplication of integers. In line with this, the research results of Lillard and Else-Quest (2006) and Mavric (2020) show that mathematics activities carried out directly can increase students' understanding of the concept of multiplication. Especially for students at the elementary school level in lower grades, in the cognitive theory of Kirschner (2002), students aged 6-8 years are still at the cognitive level. Students enjoy mathematical thinking processes that are carried out directly in calculations more than mathematical processes that are carried out abstractly.

For lower-grade students, multiplication material is difficult for students to understand. This is because hierarchically, the concept of multiplication requires several prerequisite abilities such as the concept of place value and addition (Putri et al., 2023). Apart from being repeated addition, in this study, the mathematical worksheets were also provided with scaffolding to understand multiplication in an array strategy (de Walle et al., 2016). The array strategy is a process of understanding the concept of multiplication by calculating the area of one unit (Tillema, 2013). This strategy can also be used by teachers to become a "foothold" for the concept of area of rectangular shapes, which will be studied next.

Using this alternative multiplication strategy can facilitate the learning style of each student. Some students may respond better to visual teaching methods using array strategies (Van Garderen & Montague, 2003), while others may require a more mathematical approach with repeated addition strategies (Ernest, 2013). As a reinforcement of research results, Ma (2019) also stated that innovative and participatory teaching can help students understand the concept of multiplication better. Approaches that involve visual or concrete understanding can help students build a strong foundation.

CONCLUSIONS

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

1. Learning using smart suitcase media with the help of mathematical worksheets has a good impact in improving students' mathematics learning outcomes in the multiplication of integers material, which is marked by an increase in the average value of students in each cycle, namely pre-cycle (82), cycle I (93), cycle II (94). The increase in the percentage of completeness in class also increases with each cycle, namely pre-cycle (76%), cycle I (88%), and cycle II (93%).
2. Learning using smart suitcase media assisted by mathematical worksheets has a very good effect, namely it can increase student participation and activeness in learning in class. 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 smart suitcase media with the help of mathematical worksheets is proven to be able to improve student learning outcomes in second-grade in the material of multiplication of integers. These findings can be a reference for teachers to design learning in their respective classes. Apart from that, these findings can also be followed up in experimental trial research to see the statistical effect of smart koper media assisted by mathematical worksheets.

Author contributions: SR, YWP, & MAM: compiled a mathematical worksheet to guide students in learning process in class as well as a tool for collecting data on students' abilities; **SR:** collected data; & **YNA & DANA:** acted as observers & documenters of learning process to see learning process from teacher's perspective. All authors have sufficiently contributed to the study and agreed with the results and conclusions.

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Ethical statement: The authors stated that the study was approved by the institutional ethics committee of Universitas Negeri Yogyakarta on 10 December 2023 (Approval code: T/6.27/UN34.9/KP.06.07/2023). The authors further stated that all participants in this research have signed a letter of intent and have voluntarily become participants in the research without coercion.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

REFERENCES

Bell, L. M., & Aldrigde, J. M. (2014). *Student voice, teacher action research and classroom improvement*. Sense Publishers. https://doi.org/10.1007/978-94-6209-776-6

Brumbaugh, D. K., Moch, P. L., & Wilkinson, M. E. (2005). *Mathematics content for elementary teachers*. Routledge. https://doi.org/10.4324/9781410611345

de Walle, J. A. V., Karp, K. S., & Bay-Williams, J. M. (2016). *Elementary and middle school mathematics: Teaching developmentally*. Pearson.

Ernest, P. (2013). *The philosophy of mathematics education*. Routledge. https://doi.org/10.4324/9780203058923

Fahmasari, & Darmawijoyo. (2020). Development of student worksheet of mathematical modeling learning using a financial context for senior high school students. *Journal of Physics: Conference Series, 1470*, 012049. https://doi.org/10.1088/1742-6596/1470/1/012049

Ilukena, A. M., Utete, C. N., & Kasanda, C. (2020). Strategies used by grade 6 learners in the multiplication of whole numbers in five selected primary schools in the Kavango East and West Regions. *International Education Studies, 13*(3), 65-78. https://doi.org/10.5539/ies.v13n3p65

Isnaniah, & Imamuddin, M. (2020). Students' understanding of mathematical concepts using manipulative learning media in elementary schools. *Journal of Physics: Conference Series, 1471*, 012050. https://doi.org/10.1088/1742-6596/1471/1/012050

Kanastren, O. R., Su'ad, Widjanarko, M., & Bintoro, H. S. (2023). Development of puzzle manipulative media based on realistic mathematics education approach in improving mathematical communication students. *AIP Conference Proceedings, 2733*, 030031. https://doi.org/10.1063/5.0140510

Kirschner, P. A. (2002). Cognitive load theory: Implications of cognitive load theory on the design of learning. *Learning and Instruction, 12*(1), 1-10. https://doi.org/10.1016/S0959-4752(01)00014-7

Kosko, K. W. (2019). Third-grade teachers' self-reported use of multiplication and division models. *School Science and Mathematics, 119*(5), 262-274. https://doi.org/10.1111/ssm.12337

Lillard, A., & Else-Quest, N. (2006). Evaluating Montessori education. *Science, 313*(5795), 1893-1894. https://doi.org/10.1126/science.1132362

Lo, J. J., Grant, T. J., & Flowers, J. (2008). Challenges in deepening prospective teachers' understanding of multiplication through justification. *Journal of Mathematics Teacher Education, 4*(3), 556-578. https://doi.org/10.1007/s10857-007-9056-6

Ma, F. (2019). Investigation and evaluation ofwinter indoor air quality of primary schools in severe cold weather areas of China. *Energies, 12*(9), 1602. https://doi.org/10.3390/en12091602

Mavric, M. (2020). The Montessori approach as a model of personalized instruction. *Journal of Montessori Research, 6*(2), 13-25. https://doi.org/10.17161/jomr.v6i2.13882

Mcleod, S. (2013). Kolb learning styles and the experiential learning cycle. *Simply Psychology, 8*(4), 461-478.

Nanda, I., Sayfullah, H., Pohan, R., Windariyah, D. S., Fakhrurrazi, Khermarinah, Mulasi, S., Warlizasusi, J., Hurit, R. U., Arianto, D., Wahab, A., Aini, A. N., & Bawa, D. G. A. R. (2021). *Penelitian tindakan kelas: Untuk guru inspiratif* [*Classroom action research: For inspiring teachers*]. PENERBIT ADAB.

Perbowo, K. S., Maarif, S., & Pratiwi, A. (2019). Perception of mathematics teachers in marginal regions toward the use of ICT and manipulative tools as learning media. *Journal of Physics: Conference Series, 1315*, 012042. https://doi.org/10.1088/1742-6596/1315/1/012042

Putri, B. A., Zamhari, A., Laily, I., Paramita, D. R., & Furwanti, E. (2023). Application of multiplication method using multiplication board to elementary school students. *Jurnal Ilmiah Pendidikan* [*Educational Scientific Journal*]*, 2*(2), 252-257. https://doi.org/10.55904/educenter.v2i2.766

Reeves, D. B. (2008). *Reframing teacher leadership to improve your school*. Association for Supervision and Curriculum Development.

Safi, F., & Desai, S. (2017). Promoting mathematical connections using three-dimensional manipulatives. *NCTM, 22*(8), 101-111. https://doi.org/10.5951/mathteacmiddscho.22.8.0488

Sarama, J., & Clements, D. H. (2009). "'Concrete'" computer manipulatives in mathematics education. *Child Development Perspectives, 3*(3), 145-150. https://doi.org/10.1111/j.1750-8606.2009.00095.x

Sari, N., Prasetyawati, Y., Sukmaningthias, N., & Helen Simarmata, R. (2023). Development of e-worksheet based on realistic mathematics education to support mathematical literacy skills of junior high school students. *E3S Web of Conferences, 400*, 03006. https://doi.org/10.1051/e3sconf/202340003006

Suherman, Rahmadani, N. A., Vidákovich, T., Mujib, Fitria, N., Putri, N. I. S., Addarojat, M. R., & Priadi, M. (2021). SQ3R method assisted by ethnomathematics-oriented student worksheet: The impact of mathematical concepts understanding. *Journal of Physics: Conference Series, 1796*, 012059. https://doi.org/10.1088/1742-6596/1796/1/012059

Supriyanto, J., Suparman, & Hairun, Y. (2020). Design of worksheets for RME model to improve mathematical communication. *Universal Journal of Educational Research, 8*(4), 1363-1371. https://doi.org/10.13189/ujer.2020.080429

Tillema, E. S. (2013). A power meaning of multiplication: Three eighth graders' solutions of Cartesian product problems. *The Journal of Mathematical Behavior, 32*(3), 331-352. https://doi.org/10.1016/j.jmathb.2013.03.006

Van Garderen, D., & Montague, M. (2003). Visual-spatial representation, mathematical problem solving, and students of varying abilities. *Learning Disabilities Research and Practice, 18*(4), 246-254. https://doi.org/10.1111/1540-5826.00079

Wong, M., & Evans, D. (2007). Improving basic multiplication fact recall for primary school students. *Mathematics Education Research Journal, 19*(1), 89-106. https://doi.org/10.1007/BF03217451