Research Article https://doi.org/10.12973/eu-jer.12.2.795

European Journal of Educational Research
Volume 12, Issue 2, 795 - 810.
ISSN: 2165-8714
http://www.eu-jer.com/

Digital Puzzle Worksheet for Identifying Metacognition Level of Students: A Study of Gender Differences

Ramlah*
Universitas Singaperbangsa Karawang, INDONESIA

Agung Prasetyo Abadi
Universitas Singaperbangsa Karawang, INDONESIA

Dewi Siti Aisyah
Universitas Singaperbangsa Karawang, INDONESIA

Karunia Eka Lestari
Universitas Singaperbangsa Karawang, INDONESIA

Mokhammad Ridwan Yudhanegara
Universitas Singaperbangsa Karawang, INDONESIA

Received: July 1, 2022 ▪ Revised: November 21, 2022 ▪ Accepted: March 7, 2023

Abstract: Digital puzzle worksheet (DPW) is innovative teaching material designed using open-source software such as Canva and Liveworksheets. Subsequently, puzzle games in the form of questions can improve problem-solving skills by engaging in metacognitive processes. This research used a case study method to describe the impact of applying the DPW to identify the metacognition levels of students through the assignment of contextual maths problems. The source of informants was third-grade elementary school students in West Java, Indonesia. Test instruments, observation sheets, and interviews were used, while data analysis adopted an iterative model. Furthermore, the method and time triangulation increased confidence in the resulting conclusions. The results showed that male students were at the metacognitive level of 'strategic use' and 'aware use' for females, based on the characteristics of the observed metacognitive level. The most prominent feature was identifying and determining problem-solving strategies with metacognitive awareness. The reaction of students to the DPW improved problem-solving abilities, expanded conceptual understanding, and enhanced digital technology competence. Therefore, this experience was applied when solving contextual mathematical problem assignments.

Keywords: *Contextual math problem, digital puzzle worksheet, metacognition level, primary school.*

To cite this article: Ramlah, Abadi, A. P., Aisyah, D. S., Lestari, K. E., & Yudhanegara, M. R. (2023). Digital puzzle worksheet for identifying metacognition level of students: A study of gender differences. *European Journal of Educational Research, 12*(2), 795-810. https://doi.org/10.12973/eu-jer.12.2.795

Introduction

The global COVID-19 pandemic, specifically in Indonesia, justifies the establishment of a "mobile school curriculum". The curriculum emphasizes that problem-solving skills should be mastered as a key priority for Elementary School students to achieve the goals of mathematics education (Kepmentdikbud, 2020; Liljedahl et al., 2016). In various nations, particularly since 1980, the mathematics curriculum has stressed the significance of problem-solving, as identified by the findings of previous research (Aba et al., 2022; Phonapichat et al., 2014; Roberts et al., 2022).

The ability of students to solve arithmetic problems is still an issue that all parties should address (Surya et al., 2017). Data yielded evidence regarding low mathematical problem-solving abilities due to a lack of competence (Phonapichat et al., 2014). Other research findings also showed a similar problem (Amin & Mariani, 2017; Kenedi et al., 2019; Lubis et al., 2019).

One of the causes of low mathematical problem-solving skills is a lack of experience (Aba et al., 2022). Consequently, students lack learning capacities, skills, tactics, and metacognitive awareness. As reported in previous research, metacognitive activities such as planning, monitoring, and evaluating in solving problems are not successfully conducted (Abdullah et al., 2017).

Other research reported that metacognitive skills in learning mathematics are not optimal and need to be leveled up (Anthonysamy, 2021). Several findings showed that success in solving math problems is influenced by metacognition (Abdullah et al., 2017; Ahdhianto et al., 2020; Özkubat & Özmen, 2021; Ozsoy & Ataman, 2009). The students'

* **Corresponding author:**
Ramlah, Mathematics Education Department, Universitas Singaperbangsa Karawang, Karawang City, West Java, Indonesia.
✉ ramlah@staff.unsika.ac.id

metacognition is directly proportional to the mathematical problem-solving (Izzati & Mahmudi, 2018), which involves a thinking stage (Santoso et al., 2019). Furthermore, a good thought process will involve awareness of thinking. Metacognition is based on meta-levels and mental actions to guide thinking processes that can predict the success of solving practical mathematical problems (Jacobse & Harskamp, 2012; Özcan, 2016). Other analyses confirmed this statement in the findings of the research (Aurah et al., 2011; Özkubat & Özmen, 2021; Panaoura et al., 2009; Schraw & Dennison, 1994). Therefore, metacognition contributes to solving mathematical problems (Flavell, 1979; Schneider & Artelt, 2010; Schraw & Dennison, 1994). The metacognitive experience of students also has a direct impact on mathematical problem-solving performance (Özcan & Eren Gümüş, 2019).

Solso et al. (2005) showed that metacognition is an aspect of self-monitoring with personal knowledge and plays a role in helping students use their mental resources (Fisher, 1998). This ability can detect behavior in solving problems with four levels of metacognition. Swartz and Chang (1998), stated that several metacognitive indicators could detect a person's problem-solving ability involving four levels of metacognition. First, tacit use is the result of thinking without consciousness. Second, aware use is the result of thinking that uses awareness. Third, strategic use is the application of thought. Fourth, reflective use is reflective thinking (Swartz & Chang, 1998).

The results showed that gender differences affected mathematics learning for Elementary School students (Valero, 2001). However, other research stated that gender differences in metacognition were not significantly different (Jaleel, 2016; Misu & Masi, 2017) due to inconsistent results.

Digital-based teaching materials need to be developed to overcome the low ability to solve mathematical problems and train students to involve their metacognition. The digital puzzle worksheet (DPW) can be one of the innovative, technology-based teaching materials designed using Canva and Liveworksheets. Canva is an online graphic design tool that allows users to create social media posts, presentations, posters, videos, logos, and more. Specifically, it is used for creating, collaborating, and communicating visually inside and outside the classroom. Furthermore, Canva for Education is 100% free for primary and secondary teachers and students.

The innovative teaching material is an application that can be accessed on digital devices. It is in the form of worksheets and is specifically designed for third-grade Elementary School students to learn about measurement concepts such as units of length, distance, and weight. The development is an extension of previous research that has examined the effectiveness of using digital worksheets and puzzles for learning. By providing students with these interactive and engaging teaching materials, understanding and retention of measurement concepts can be improved

Figure 1. Example of a Digital Puzzle Worksheet (Ramlah, 2021a, 2021b)

Several previous research studies have developed the DPW, designed to cater to the needs of students, adapt to their characteristics, and focus on learning objectives. The worksheet developed contains reinforcement materials, systematic activities based on learning approaches (Amelia et al., 2020; Pulungan et al., 2022; Sharma, 2022), and practice questions. The results showed that digital worksheets could develop critical and logical thinking skills (Huang et al., 2007; Puspita & Dewi, 2021), train mathematical problem-solving skills (Darmawan & Yuwaningsih, 2021), and literacy (Mulyasari et al., 2022). In addition, learning using digital worksheet also makes students happy and interested in mathematics (Pulungan et al., 2022), increasing cases of learning activity and independence (Amelia et al., 2020).

Research on digital worksheet further examined the DPW as teaching material innovations. Sharma (2022) and Battocchi et al. (2010) fostered students' ability to work together. The use of games and puzzles as learning tools can improve spatial competence (Lin & Chen, 2016) and social attitudes (Lieban et al., 2018), as well as stimulate spatial intelligence (Saroinsong et al., 2021). Mathematical puzzles through digital manipulatives can improve digital problem-solving competencies (Lieban & Lavicza, 2019). Additionally, interactive puzzles increase understanding of numbers and flat shapes in early childhood between 5-7 years (Ramlah et al., 2022).

The limitations of previous research on digital worksheet and puzzles have not been applied in the learning process, developed only as needed (Mulyasari et al., 2022). The developed digital worksheet is only oriented toward metacognitive activities (Amelia et al., 2020). Digital worksheet was also developed only for autistic children (Battocchi et al., 2010). The types of puzzles are limited to geometric for children aged 4-5, stimulating spatial intelligence to recognize shapes and colors (Saroinsong et al., 2021). Designing math puzzle tasks by connecting concrete and abstract ideas through physical and digital modeling only increases geometric vocabulary and understanding of transformations (Lieban & Lavicza, 2019). The application of digital worksheet can only be used through a smartphone with a minimum of Android 10 features (Darmawan & Yuwaningsih, 2021; Lin & Chen, 2016; Pulungan et al., 2022; Saroinsong et al., 2021).

Based on these previous researches, there are many researches that have developed worksheets and combined them with digital puzzles and even seen their effect on metacognition. However, it needs to be analyzed in more depth at different levels of metacognition. Meanwhile, the pattern of metacognition level between men and women is different. This has not been discussed and observed by previous researchers, even though this is a crucial issue. Therefore, researchers try to fill in the gaps in previous studies by analyzing further based on the level of metacognition and gender.

Furthermore, the types of puzzles are focused on 'matching or jigsaw puzzles' and 'completion puzzles'. Researchers try to add variation to the type of puzzles (such as word finding puzzles and crossword puzzles based on problem solving that requires the involvement of metacognition in implementing the type of puzzles.

The problem investigated in this research is a case study found in a pilot school located in a rural area (very far from urban areas). The availability of access to technology and information in these schools is still limited. The teachers at the school have not used DPW, and most of them do not even know how to make and use it. Meanwhile, this DPW can be used to identify the level of metacognition based on gender. Thus, the result of this study contributes especially to elementary school teachers in being able to use DPW as a basis for consideration in deciding what learning approaches and media can be used by teachers according to their level of metacognition and gender.

Based on the application of the DPW, data obtained showed the average students' score of 7.95. The average score for contextual math problem-solving tasks is 7.62, and the data showed that around 86.48% of students are good problem-solvers. This provided a basis to examine, identify and describe the contribution of digital puzzles to the metacognition of Elementary School students (Madrasah Ibtidaiyyah/MI) when solving contextual math problems. As a limitation, the impact of the DPW teaching materials was examined in determining the level of third-grade Elementary School students based on gender.

Methodology

Research Design

A qualitative case study method was used to uncover research answers to describe metacognition levels based on a gender perspective in solving contextual math problems. Furthermore, the three types of the DPW designed in canvas contained material identity components, learning videos, sample questions, and student activities. Problem-solving exercises were presented in puzzle games, such as jigsaws, charades, and crosswords as shown in Figure 1. The designed DPW was then transferred into interactive exercises. Students could operate the DPW easily according to the instructions listed.

Besides functioning as an interesting and fun teaching material, the DPW can also develop mathematical problem-solving skills, thinking power, awareness of thinking, and digital literacy. This is because puzzle game questions are expected to be solved from easy to difficult levels through digital devices. The advantage is that these games assist students in continuing to train and develop their logical thinking (Huang et al., 2007).

Problems are indirectly identified when puzzles are solved, which require planning to determine the strategy or formula used. In evaluation activities, the appropriateness of the answers given to the problem can be reconsidered, even though the digital puzzle-solving activities are different. Some students use their awareness of thinking to solve digital puzzle problems hierarchically. In contrast, others make decisions without thinking due to differences in awareness or metacognition level.

One of the advantages of the DPW is that students can rework the puzzle without being limited by time. Therefore, when solving the problems presented, thinking awareness can also be developed. The continuous application of the DPW has implications for the awareness or level of metacognition in solving mathematical problems.

Sample and Data Collection

The DPW was implemented in third-grade students across two elementary schools in West Java, Indonesia (Madrasah Ibtidaiyyah/MI). Learning mathematics was carried out six times face-to-face in class and divided into three types of DPW, namely length, distance, and weight unit material. In collecting samples and data involving researchers, teachers and students.

The researcher has four central roles, namely as a DPW designer, an observer during the implementation of learning, an analyzer of student DPW work results, and an observer to determine the level of students' metacognition. As a DPW designer, the researcher does the following: 1) analyzes the situation of students' needs; 2) determine learning materials; 3) make a DPW design; 4) finalizing the creation of the DPW using the Canva application; 5) upload the DPW in the 'liveworksheets' account so that it can be accessed online. As an observer of the implementation of learning, the researcher directly observed the process of learning mathematics using DPW. Meanwhile, as an analyzer of student DPW work results, researchers carry out activities to analyze all student work results after solving all the problems presented at DPW. As an observer to determine the level of students' metacognition, the researcher carried out activities including observing students' metacognitive activities (planning, monitoring and evaluation) using observation sheets.

Teachers have two central roles, namely as validators of research instruments and executors who implement DPW. As a research instrument validator, the teacher validates the test instruments (contextual problem-solving tasks) and interview sheets. As an implementation of DPW, the teacher gives DPW to students as an evaluation tool for the material that has been delivered. The DPW completion process was carried out within 30 minutes. The DPW work score can be seen after the student has completed all the problems and ends it by clicking the 'finish' button. If the student has not met the minimum completeness criterion score, then the student can repeat it at home. The teacher was fully responsible for the implementation of the DPW, and was responsible for the validation results of the test instruments and interview sheets given as they should.

Students have three central roles, namely as a solver of math puzzle problems in each DPW, completing contextual problem-solving assignments, and providing information/data to determine students' metacognition levels. Especially for students who provide information in determining the level of metacognition, two students are taken based on gender.

According to the various considerations, the respondents involved consisted of male and female students. They were selected using a purposive sampling technique after considering certain criteria based on the highest total score on the DPW and the contextual problem-solving task. In this case, the results of student scores are the main information used to describe metacognition levels based on gender. The following is a recapitulation of worksheets and problem-solving task scores for male, which are presented in Table 1.

Table 1. Recapitulation of Worksheet Scores and Problem-solving Tasks for Male

Respondents	Gender	DPW Total Score	Problem-Solving Task Total Score
R3	Male	8.0	8.3
R4	Male	7.7	8.1
R5	Male	8.0	7.9
R8	Male	8.7	7.5
15	Male	9.3	9.0
R16	Male	8.0	7.5
R18	Male	7.7	7.7
R19	Male	8.0	8.2
R20	Male	8.7	8.2
R21	Male	7.3	7.7
R22	Male	8.3	8.0
R23	Male	8.3	8.0
R24	Male	6.0	7.3
R27	Male	8.0	7.7
R28	Male	8.7	8.3
R29	Male	7.0	7.7
R34	Male	7.3	7.8
R35	Male	8.3	8.1

Tables 1 and 2 show that the respondents are male, with the highest score of R15. In contrast, the female respondent with the highest score is R6. The determination is based on the highest average score of the DPW work and contextual math problem-solving tasks. The reason for the determination was that respondents can describe the process of solving the problem and the process of awareness or metacognition level. Therefore, respondents can provide the information needed under the research objectives.

Table 2. Recapitulation of Worksheet Scores and Problem-Solving Assignments for Female

Respondents	Gender	DPW Total Score	Problem-Solving Task Total Score
R1	Female	7.7	8.2
R2	Female	8.0	7.9
R6	Female	9.0	8.5
R7	Female	7.7	7.7
R9	Female	8.7	7.3
R10	Female	8.3	7.1
R11	Female	8.3	6.5
R12	Female	7.3	6.3
R13	Female	7.7	5.9
R14	Female	8.0	5.2
R17	Female	6.7	6.5
R25	Female	8.0	7.5
R26	Female	7.3	7.7
R30	Female	7.3	7.0
R31	Female	8.7	8.0
R32	Female	8.7	8.3
R33	Female	8.7	8.0
R36	Female	7.3	7.5
R37	Female	7.7	7.8

There are three types of instruments used, namely observation sheets on the results of DPW work, contextual mathematical problem-solving assignments and unstructured interviews given to research respondents. The DPW work observation sheet is used to obtain information/data on students' metacognition levels. The problem-solving task instrument is used to reveal the problem-solving process, while unstructured interviews are used to obtain more complete data regarding the level of students' metacognition. Data from the results of the three instruments obtained from respondents were matched with metacognition levels and indicators (in Table 3).

The following assignments are related to contextual math problem-solving questions. These assignments consist of materials units of length, distance, and weight.

Task 1: Mr. Asep wants to make his house fence out of bamboo. He has eight bamboo sticks measuring 200 cm for each stick. If Pak Asep only needs 1400 cm of bamboo, how many meters of bamboo are left?

Task 2: Rasya is going to visit Uncle's house. The distance from Rasya's house to Uncle's house is three times the distance from her house to the market. If Rasya's house is 2 km from the market, how many meters is her house to Uncle's house?

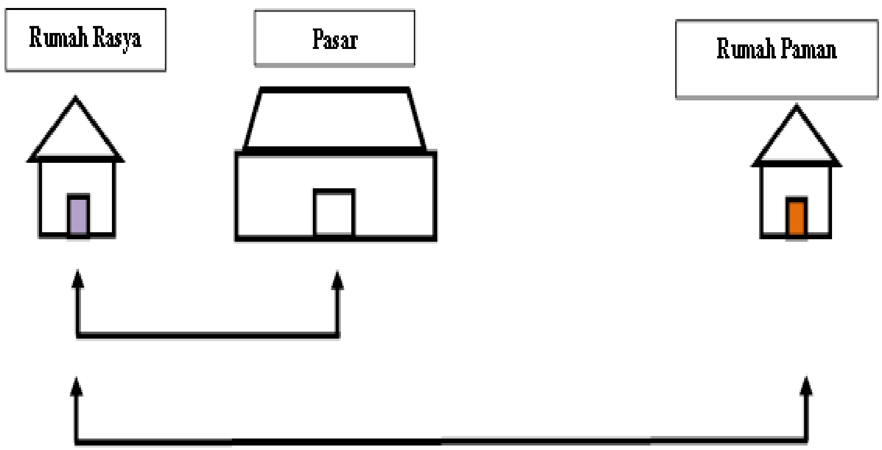


Figure 2. Illustration of Contextual Problem in Task 2

Task 3: Mother buys sugar at the market, and granulated sugar is stored in two plastic bags A, weighing 3 kg 250 grams, and B, 150 grams lighter. How many grams weigh the sugar in plastic bag B?

Contextual math problem-solving assignments are given to respondents at the end of the whole mathematics learning using the DPW. These assignments present the material, namely units of length, distance, and weight. Meanwhile, test instruments, observation sheets, and interviews were validated by considering internal validity based on the expert judgment of a lecturer and two home teachers. The internal validity shows that the test instruments and interview sheets are in a good category, with a percentage of 78%, and the indicators in the metacognition level are presented in Table 3.

Table 3. Metacognition Levels and the Indicators

Metacognition Level	Indicator		
	Planning	**Monitoring**	**Evaluation**
Tacit Use	- Respondents cannot show what data they knew (R_1), - Respondents cannot show what data were asked (R_2), - Respondents cannot express their problems clearly (R_3).	- Respondents do not relate the awareness of various things that can be monitored (RP_1), - Respondents do not know the concept errors and answers obtained (RP_2).	- Respondents did not evaluate the answers received (RE_1).
Aware Use	- Respondents have problems thinking of formulas and their application (S_1), - Respondents only disclosed part of what was stated in writing (S_2), - Respondents know the problem because they can express it clearly (S_3).	- Respondents are unable to complete their responses because they were confused (SP_1), - Respondents know the concept errors (formulas) and calculation methods but cannot render any correction (S_2).	- Respondents did not evaluate the answers received (RE_1), - Respondents evaluated their answers but were unsure of the written answers (SE_1).
Strategic Use	- Respondents know the problem because they can express it clearly (S_3). - Respondents do not experience difficulties and doubts in getting the formula and the calculation (Q_1) - Respondents can explain most of what is written (Q_2).	- Respondents know the misconceptions and calculation methods (QP_1). - Respondents can express reasons supporting their thoughts' results (QP_2).	- Respondents did not evaluate the answers received (RE_1). - Respondents rated but were not sure about the results obtained (QE_1).

Adapted from Swartz and Perkins (1989).

Analyzing of Data

The analytical method used is an iterative model (Miles & Huberman, 1994). Broadly speaking, the stages of the research are data collection, data reduction, data presentation and conclusion. Before arriving at the final stage of data analysis, the researcher chose the validity strategy to be used, namely triangulation (method and time triangulation) and used appropriate references. Specifically, to obtain interview data, researchers pay attention to the following: 1) willingness of respondents; 2) the time and setting of the interview; 3) the health condition of the respondent; and 4) the communication skills of the respondents.

Research data from the results of observation sheets and problem-solving assignments were analyzed by matching the results using metacognition levels and indicators. Researchers use interview data to strengthen the conclusions of the two data. The goal is to verify the accuracy of the results. In the summarizing stage, the researcher summarizes all the existing data and specifies the things that are important to summarize long words or sentences into short sentences. Then the data is presented in the form of a brief description, by systematically compiling the data, followed by writing the data in narrative form. The final stage is the process of drawing conclusions from the information obtained from the informant. The iterative model data analysis set is presented in Figure 3. The entire data analysis process was carried out by researchers together with teachers to discuss research results and observations.

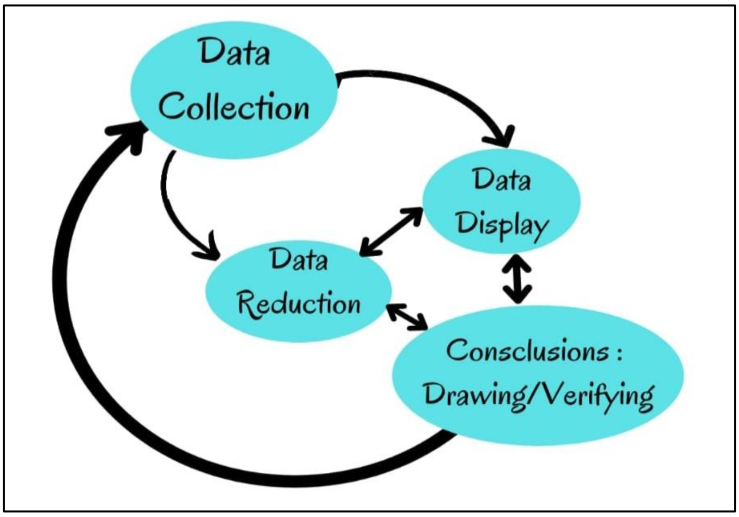


Figure 3. Qualitative Iterative Model

Findings/Results

The descriptive statistic of problem-solving tasks for females and males are summarized in Table 4. The result shows that the minimum score of females for each task is lower than the male score, but the maximum score of the female is never less than the male score. Therefore, range of the female score is wider than the male score. Similarly, the average score of females for each task is lower than the male score with various of standard deviation.

Table 4. Statistical Descriptive Comparison Between Female and Male

Problem-Solving Task	**Taks 1**		**Taks 2**		**Taks 3**	
Respondent	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**
n	19	18	19	18	19	18
Minimum	3.8	5.0	5.0	7.5	6.3	7.5
Maximum	7.8	7.5	9.4	9.4	10	10
Range	4.1	2.5	4.4	1.9	3.8	2.5
Average	5.9	6.0	7.8	8.5	8.3	9.0
Standard Deviation	1.0	3.5	1.3	0.6	1.2	0.8

The DPW teaching materials implemented for third-grade elementary school students in learning mathematics on the subject matter of length (DPW 1), distance (DPW 2), and weight (DPW 3) units. These materials were presented to students after the explanation by the teacher. They can be accessed repeatedly through digital devices such as computers, laptops, or cell phones. The following is a descriptive statistic for the average score of 37 students in DPW 1 to 3.

Table 5. Descriptive Statistics of Digital Puzzle Worksheet Activity Results

	DPW 1	**DPW 2**	**DPW 3**
Total Students	37	37	37
Average Score	7.46	9.14	7.27

The results of the Digital Puzzle Worksheet quizzes presented in Figure 4. Table 5 and Figure 4 show that the overall average of DPW 1 to 3 is 7.95, and the average score of students is 7.46, 9.14, and 7.27, respectively.

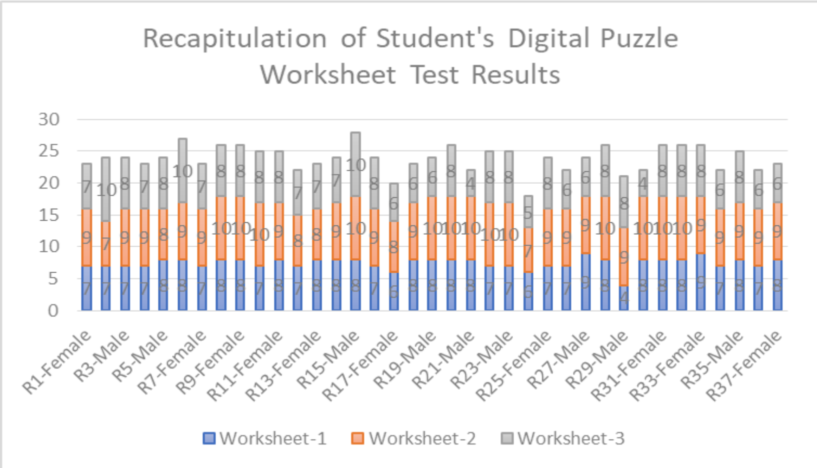


Figure 4. Recapitulation of Student's Digital Puzzle Worksheet Test Results

After completing the activity, contextual math problem-solving assignments are presented to determine the implications of giving the DPW in measuring the ability to solve mathematical problems using metacognitive awareness. The recapitulation of descriptive statistics on the results of the average DPW score and problem-solving assignments is presented in Table 6.

Table 6. Descriptive Statistics of DPW Activity Scores and Problem-Solving Tasks

	DPW Activity Score	Problem-Solving Tasks
Total Students	37	37
Average Score	7.95	7.62

The diagram in Figure 5 shows the results of the DPW activity scores and the contextual math problem-solving task. Table 6 and Figure 5 show the average overall score is 7.78, while the DPW activity and problem-solving task test results are 7.95 and 7.62, respectively. The average value indicates that the students' ability to solve math problems is quite good.

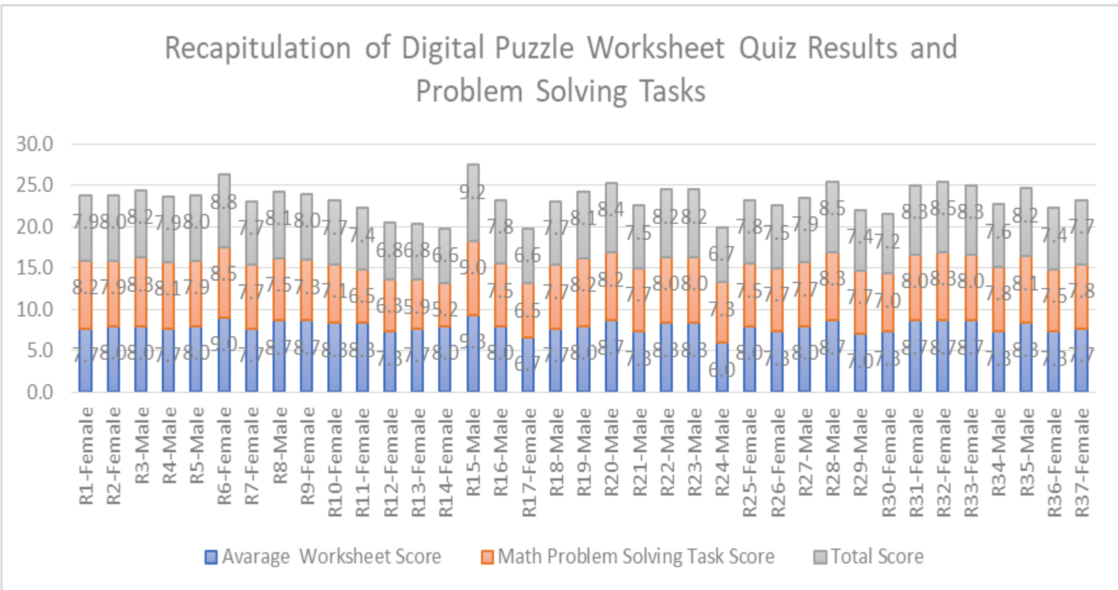


Figure 5. Digital Puzzle Worksheet Recapitulation and Problem-Solving Tasks

The results of a review of contextual mathematics problem-solving task documents, observation sheets, and interviews with female respondents (RP) are presented in Tables 7, 8, and 9. Each table presents the results of the mathematical problem-solving task on the material units of length, distance, and weight respectively.

Table 7. Summary of the Task 1 Result for Female

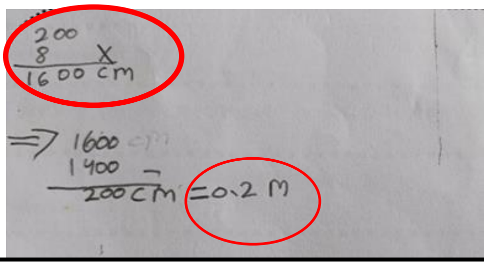
Metacognitive Activity		
Planning	**Monitoring**	**Evaluation**
- RP identifies the problem by reading the questions repeatedly four times. Based on these answers, the known data are written and asked from the questions. This is under the data obtained from observations in class. RP only disclosed some known data when interviewed (S_2) but could indicate problems (S_3) following the rush to read the question. In addition to identifying, a solution strategy was obtained to determine material concepts and formulas. From the results, RP stated, 'I thought about this concept because the material is the same as in the DPW'.	- RP applies a settlement strategy by multiplying the number of bamboo by the length, then reducing the size. The length in cm was then converted to m. The concept of 'multiplicatio' was related to the unit of length with the questions given. RP realized errors in concepts and calculations that were not corrected (SP_2). - RP solves the problem by carrying out the correct calculations, but the wrong solution is presented in determining the final result. Furthermore, the problem-solving process conducted was not sequential. From the point of view of technical multiplication rules, RP is not quite right in placing the positions, as shown in the picture. The final answer was wrong when interviewed, and 200 cm was converted to m before dividing by 100. 	- Based on the results of the written homework answers, the conclusion of the answer was not written. The results showed that RP did not re-examine the final solution obtained (RE_1).

Table 8. Summary of the Task 2 Result for Female

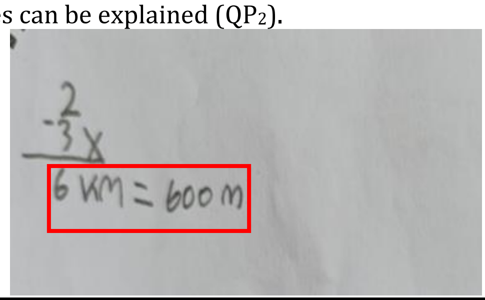
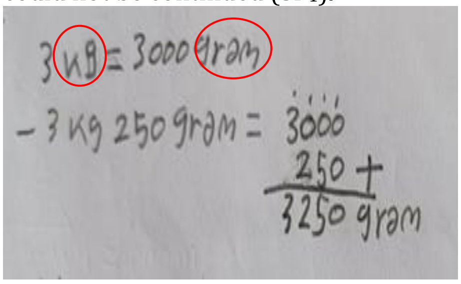
Metacognitive Activity		
Planning	**Monitoring**	**Evaluation**
- RP identifies the problem by reading the questions twice and writing down the known data. The formula to be used was also determined (Q_1). Furthermore, the known and asked data were shown when interviewed (S_3). There was no difficulty experienced in obtaining and calculating the formula (Q_1). This was shown because of previous learning experiences using the DPW.	- RP implements the formula well by conducting the calculation according to the presented problems. However, the troubleshooting steps were not carried out efficiently. During the interview, RP reported, *'I understood the picture presented in the question, hence I decided to multiply the distance from Rasya's house to the Uncle's house three times from her house to the market'.* Based on the results of written answers and interviews, the reasons for the thought processes can be explained (QP_2). 	- In task 2, RP did not write a conclusion. The results showed that the final answer was not evaluated (RE_1). This is because the importance of checking the solutions was not considered.

Table 9. Summary of the Task 3 Result for Female

Metacognitive Activity		
Planning	**Monitoring**	**Evaluation**
- The interviews showed that RP had problems thinking about the application formula. The question's meaning was not understood following the hurry to read, and the question was very long (S_1). The questions were identified by repeatedly reading three times. The RP was confused about writing down the known and asked data. Therefore, only a few data were written down (S_2), and the selected strategy was not sure.	- Identification of written answers showed that RP could not solve the questions correctly. RP wrote down the change from 3 kg to 3000 g and broke it down. The writing of symbols is not consistent with each other. The interviews showed that *'RP only decomposes 3 kg into 3000 g, and 3 kg 250 g into 3000 plus 250 to 3250 g' I could not go on because of the complexity and confusion'*. Based on the results, it can be concluded that RP was confused, and the settlement process could not be continued (SP_1). 	- RP could not adequately address the problem based on the planning and monitoring stages. A part of the process was only completed, and the final answer was not evaluated (RE_1). This is consistent with the observation that respondents did not write their final answers on the worksheets during the DPW activity.

Based on the results of data recapitulation, it can be concluded from the three contextual problem-solving questions that female respondents are dominant with the characteristics of the metacognitive level of 'aware use'. These respondents can (1) identify problems and define concepts fairly well, (2) link concepts with theories that are relevant to the problems presented, and (3) have fairly good representations. Summary of problem-solving task results contextual, observation, and interview sheets identification of respondents' (male) metacognition levels in Task 1 (length unit), Task 2 (distance unit), and Task 3 (weight unit) are represented in following tables.

Table 10. Summary of the Task 1 Result for Male

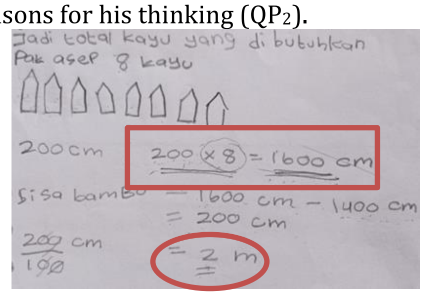
Metacognitive Activity		
Planning	**Monitoring**	**Evaluation**
- Male respondents (RL) can identify problems that are well presented. RL understands the situation by clearly writing down the known and asked data (S_3) and can clearly express most of what is written (Q_2). The question was read over and over. Based on the interview results, the questions were easy to understand because they were presented according to daily life. - Based on the identification results, RL determines the strategy and formula used. There was no difficulty or hesitation in obtaining the procedure (Q_1). RL uses a system by illustrating 8 logs, using the concept of multiplication, and changing the length units from cm to m. Presenting interesting pictures on the DPW gave him a meaningful experience. *"I like learning while playing when completing the DPW activities, making me think about solving the puzzles".*	- RL writes down the number of bamboo needed for the complete plan and described eight sticks. Furthermore, the calculation process is well conducted. Based on the description of the answers, RL writes down the stages to conclude the final results in detail. In completing this task, multiplication is used to express the required length of bamboo. Based on the confirmation from the interview, RL stated that illustrating the bamboo made it easier to understand the problem. "When I read this problem, I could imagine it, and I drew eight bamboos. It is easy to calculate the length of all the bamboos, and I multiplied eight bamboos by the length of the bamboo". Based on this, RL can explain the reasons for his thinking (QP_2). 	- The written answers showed that the RL did not assess whether the final results were under the questions. This was supported by observational data in mathematics class using the DPW, that RL did not write down his final answer on his activity sheet. The interview results showed that RL did not check the final results obtained (RE_1). RL stated, *"I did not double check the calculations or the final answer because I believed the answer was correct".* RL did not realize the importance of evaluating at the problem-solving stage. The awareness of thinking has not led to the importance of this being conducted.

Table 11. Summary of the Task 2 Result for Male

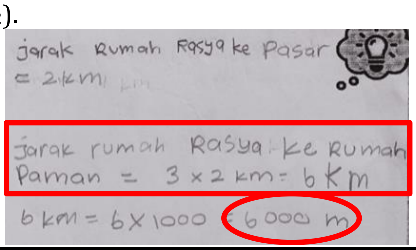
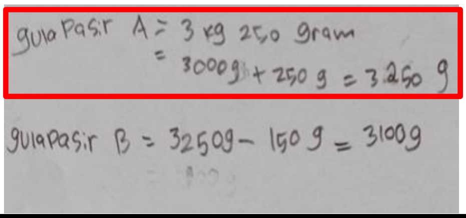
Metacognitive Activity		
Planning	**Monitoring**	**Evaluation**
- RL identifies a problem by reading it twice, and the known data is written twice. The problem is clear during the interview (S_3). RL can determine the concept of material according to the problem. On the identification results, there was no difficulty in determining the formula and doing the calculations (Q_1). "Reading the problem twice and paying attention to the pictures, I can determine a strategy to solve it." RL has good awareness of thinking, and the written content can be explained (Q_2). - When identifying the problem, RL could easily understand the problem because of previous learning experiences using DPW to improve problem-solving skills, habits, and awareness of thinking.	- In this case, it is easy for RL to monitor the thought processes. It only sees the picture presented and can solve the problem. The solution strategy is determined by writing down information on the distance from Raya's to Uncle's house, which is 2 km. Furthermore, RL multiplied the distance between Rasya's and Uncle's houses and can perform length unit conversions precisely. The results of the RL interview stated, "Task 2 is easier because it only multiplies a". The question is continued, and the answer is 6 km or 6000 m. RL replied, "both are correct, but because, in the problem, the units are in m". Based on this, RL has good metacognitive awareness and can express reasons supporting the results of the thoughts (QP_2). 	- RL can solve the problem well. However, the interview results revealed that he did not evaluate the process and final results (RE_1). RL stated, "I am very confident with my answer because by looking at the pictures, I can determine that the distance from Raya's house to Uncle's house is 6000 m".

Table 12. Summary of the Task 3 Result for Male

Metacognitive Activity		
Planning	**Monitoring**	**Evaluation**
- The method used by RL when identifying problems is to re-read the questions twice. The known information was written but not the queried data, and the problem was clearly stated (S_3). In the identification results, there was no difficulty determining the material concept and the calculations (Q_1). The interviews showed that in task 3, the concept used was the unit of weight, namely converting kilograms into grams, and for calculations only using subtraction operations. RL can explain what is written (Q_2).	- In the completion plan execution stage, RL used a data simplification strategy. For example, sugar A = 3 kg 250 g was simplified by equating the unit weight to 3000 g + 250 g = 3250 g. However, RL could not describe the problem-solving process in a structured manner. RL understands the conversion of kg to g that 3 kg = 3000 g, this can be seen from the answers given, and no calculation was performed. The problem was effectively solved, and the results were presented. RL can show the reasons for this thought (QP_2). It was shown from the interview results that "the unit of kg for granulated sugar A was changed to 3000 g, hence, it was easy to determine the weight of granulated sugar B, only minus 150". 	- Based on the written answers, RL provided the correct answer and was not double-checked. Furthermore, the completion process and the result were not evaluated (RE_1).

The results of data recapitulation of contextual math problem-solving assignments and interviews are presented in Tables 10, 11, and 12, showing that male respondents can (1) identify problems, (2) connect material concepts based on problems, (3) solve problems by choosing the right strategy, (4) using appropriate concepts or formulas, and (5) communicating the final results properly. Referring to Table 3, male respondents are at the 'strategic use' metacognition level based on the identified characteristics.

Discussion

The qualitative case study found a hypothesis that the implications of the DPW teaching materials contributed to determining the level of students' metacognition. Based on Tables 7, 8, and 9, information was obtained that female respondents were at the 'aware use' level when understanding problems. Identification was conducted by repeatedly reading to show the known data. In addition, the completion strategy can be determined by defining the concept or formula used. Students at the 'aware use' level can determine concepts or procedures due to declarative knowledge and previous learning experience using the DPW teaching materials (Schraw et al., 2006).

It is easier for female respondents to identify problems and determine strategies when visualized in the form of pictures. This is an implication of the presentation of the DPW, which presents interesting images, but does not lead to contextual form. Female respondents tend to be characterized by 'strategic use' when faced with contextual problems that present images. This is because female can quickly identify and understand problems clearly. They conduct a settlement strategy in monitoring activities, which connects material concepts with problems. In the evaluation activity, most of the 'aware use' respondents do not consider the answers under the questions. In contrast, other findings state that students can assess their work (Rosikhoh et al., 2022).

Male respondents with a metacognition level of "strategic use" can identify problem tasks very well. Metacognitive activities at the planning stage can verify problems by clearly disclosing the most known and asked data. Respondents determine problem-solving strategies well to improve math performance (Özkubat & Özmen, 2021). There was no difficulty in selecting the formulations and determining the calculation. The findings showed that male respondents could represent problems through pictures and prior knowledge using the DPW. Presentation of picture illustrations is one way to overcome difficulties in solving contextual math problems (Rellensmann et al., 2022).

Male respondents with a 'strategic use' metacognition level can carry out planning and monitoring activities very well. This finding indicated that male respondents are not consciously thinking about evaluation activities. Wilson and Clarke (2004) and Whitebread et al. (2007) stated that the most common evaluation activities were identified. The focus of the respondents was only on the result, without realizing the appropriateness of the process.

In addition, it is easier to solve math problems by involving good metacognition when represented by an image/model (Posamentier & Krulik, 2009). This is under the DPW concept, which uses various puzzle games. The pictures can improve students' visualization and metacognitive skills (Lin & Chen, 2016; Sword & Director, 2005). In contrast to Saroinsong et al. (2021), the puzzle developed is limited to recognizing shapes and colors. Whereas Lin and Chen (2016) showed that digital puzzle games only improve students' spatial abilities.

This teaching material has implications in terms of achieving good quality learning (Yusuf & Widyaningsih, 2020), specifically mathematics which provides experience and increases skills in using digital technology (Belbase, 2020), and student-centered task development (Ratnayake et al., 2020). The DPW was developed for the alpha generation according to the needs and characteristics of students and the goals of learning mathematics. Based on Table 7, students can complete the contextual mathematical problem-solving tasks for the three tasks by fulfilling the stages of understanding the problem, planning, and implementing solutions (Polya, 2004).

The result of the research above is in line with some results of previous studies. As it was done by Amelia et al. (2020), who concludes that digital worksheets can train students' metacognitive awareness through metacognitive activities. Similarly, Darmawan and Yuwaningsih (2021) conclude that digital worksheets can train and improve students' mathematical problem-solving abilities. This corresponds to the average score of student problem solving assignments of 7.62 (Table 6).

Although the novelty of this research is not significantly arisen, the result of this study provides new information that can be developed further. The result of this study is more focused on the development of DPW which is intended to identify the level of metacognition based on gender, which of course is different from previous studies.

Another difference is from a study conducted by Lin and Chen (2016) that obtained that digital puzzle games can develop the cognitive abilities of elementary school students. The difference is in the result of this study which have not discussed gender difference and metacognition aspects. In addition, the research conducted by Sharma (2022) has developed digital puzzle worksheets in general. The research has not focused on subject matter for elementary school students.

Conclusion

The main objective was to describe the impact of the DPW materials in identifying the metacognition level of Elementary School students (Madrasah Ibtidaiyyah/MI) based on gender when completing contextual mathematics problem-solving assignments. This research determined that the DPW materials mostly focused on development to fulfill needs, could not be applied in the learning process, and were oriented towards metacognition, spatial intelligence, increased geometric vocabulary, and problem-solving. In addition, the worksheets developed for children with autism and early childhood are limited to geometry, numbers, and plane shapes puzzles. From the point of view of accessing the worksheets, it can only be used through a smartphone with a minimum of Android 10 features.

The development is oriented towards metacognitive activities to enhance the involvement of conscious thinking when solving mathematical puzzle problems. This breakthrough was made to complement the previous literature studies. In essence, the DPW teaching materials contribute to determining the level of students' metacognition which is identified specifically through the given contextual mathematics problem-solving assignments. The results showed that students' experience using the DPW continuously impacts metacognitive awareness while solving contextual math problems (in Table 11) to identify the level of metacognition (in Table 3).

The results led to new knowledge in which the DPW was developed according to the needs and characteristics of Elementary School students and the goals of learning mathematics. This includes mastering problem-solving competencies with enhanced metacognitive awareness, proposed to the MGMP Mathematics Elementary School or other teaching professions to overcome the challenges faced by teachers during teaching and learning activities in class and online. Furthermore, the DPW allows teachers to collaborate with strategies, approaches, or learning models that emphasize the involvement of metacognition to improve mathematical problem-solving skills, specifically students' understanding of the concepts of units of length, distance, and weight.

Recommendations

Considering the results and discussion, several recommendations offered for teachers include (a) using the DPW as teaching materials to achieve the goals of learning mathematics, specifically in terms of training metacognitive awareness in solving problems, (b) compiling digital-based teaching materials "liveworksheet" by adjusting the needs, characteristics, learning objectives and educational level of students, and paying attention to the elements of presenting puzzles including contextual image illustrations, and (c) using digital media as a tool that can support the learning process. For future analyses, it is possible to extend this research to (a) develop a valid observation sheet instrument in identifying metacognition levels, (b) other materials or subjects in metacognition studies and their relationship or influence on mathematical abilities to extract more information and provide benefits for the improvement of learning.

The results of this study raise some open problems for future work, i.e., (a) analyzing metacognitive level and gender difference using k-means clustering and correspondence analysis (see Lestari et al., 2023; Lestari et al., 2022; Yudhanegara & Lestari, 2019); and (b) general comparison of metacognitive level and gender for each level of problem solving ability (high, medium, low).

Limitations

This research was conducted during the COVID-19 pandemic, and some areas of West Java, Indonesia, are still in the red zone. The impact of these conditions is that some elementary schools (Madrasah Ibtidaiyyah/MI) conduct online and offline learning. Therefore, this research has limitations in its implementation, such as (a) the components presented in the DPW teaching materials do not provide "space" for students to describe their thinking results, (b) the DPW teaching materials are adapted based on needs and characteristics students, as well as learning objectives in the research area carried out (c) metacognition levels analyzed were limited to a highly capable man and woman, (d) the substance studied is limited to material in units of length, distance and weight only, (e) the educational level of students analyzed is limited to Elementary School students aged 8-11 years, (f) the observation sheet used is only limited to a list of checklist statements. Therefore, it is less referent in describing its activities to detect students' metacognition levels.

Acknowledgements

The authors are grateful to the HIPKA 2020 LPPM Universitas Singaperbangsa Karawang for research funding and anonymous reviewers who have provided constructive comments to improve the previous version of the manuscript. The authors also thanks to Mr. Anji Taukhidani and Miss. Tety Febrianti as teacher in research team.

Authorship Contribution Statement

Ramlah: Conceptualization, design, collecting the data, analyzing and interpreting the data, and writing. Abadi: Material support, design, editing, and writing. Aisyah: Supervision, design, editing, writing. Lestari: Data analysis, and writing. Yudhanegara: Data analysis, critical revision of manuscript, and writing.

References

Aba, M. M., Anshar, S. P., & Ralmugiz, U. (2022). Students' numerical literacy in solving islamic-based problems: Studies on jenis kelamin perspectives. In B. K. Prahani, N. Fitriyati, Y. Mahatma, Sueb, M. F. Ubaidillah, & K. Wahyu (Ed.), *Proceedings of the International Conference on Madrasah Reform 2021 (ICMR 2021)* (pp. 25-30). Atlantis Press. https://doi.org/10.2991/assehr.k.220104.005

Abdullah, A. H., Rahman, S. N. S. A., & Hamzah, M. H. (2017). Metacognitive skills of Malaysian students in non-routine mathematical problem solving. *Bolema - Mathematics Education Bulletin*, *31*(57), 310–322. https://doi.org/10.1590/1980-4415v31n57a15

Ahdhianto, E., Marsigit, Haryanto, & Santi, N. N. (2020). The effect of metacognitive-based contextual learning model on fifth-grade students' problem-solving and mathematical communication skills. *European Journal of Educational Research*, *9*(2), 753-764. https://doi.org/10.12973/eu-jer.9.2.753

Amelia, D., Anshory, I., & Yunus Saputra, S. (2020). Pengembangan LKPD berorientasi metakognisi di SD Muhammadiyah 5 Bumiaji [Development of metacognition oriented student worksheets in Muhammadiyah 5 Bumiaji elementary school]. *Jurnal Inovasi Pembelajaran*, *6*(1), 113 – 123. https://doi.org/10.22219/jinop.v6i1.7168

Amin, I., & Mariani, S. (2017). PME learning model: The conceptual theoretical study of metacognition learning in mathematics problem solving based on constructivism. *International Electronic Journal of Mathematics Education*, *12*(3), 333-352. https://doi.org/10.29333/iejme/616

Anthonysamy, L. (2021). The use of metacognitive strategies for undisrupted online learning: Preparing university students in the age of pandemic. *Education and Information Technologies*, *26*(6), 6881–6899. https://doi.org/10.1007/s10639-021-10518-y

Aurah, C. M., Koloi-Keaikitse, S., Isaacs, C., & Finch, H. (2011). The role of metacognition in everyday problem solving among primary students in Kenya. *Problems of Education in the 21st Century*, *30*, Article 9. https://bit.ly/Aurah2011

Battocchi, A., Ben-Sasson, A., Esposito, G., Gal, E., Pianesi, F., Tomasini, D., Venuti, P., Weiss, P., & Zancanaro, M. (2010). Collaborative puzzle game: A tabletop interface for fostering collaborative skills in children with autism spectrum disorders. *Journal of Assistive Technologies*, *4*(1), 3–13. https://doi.org/10.5042/jat.2010.0040

Belbase, S. (2020). Early undergraduate emirati female students' beliefs about learning mathematics using technology. *European Journal of Educational Research*, *9*(3), 1235–1255. https://doi.org/10.12973/eu-jer.9.3.1235

Darmawan, M. A., & Yuwaningsih, D. A. (2021). Pengembangan E-LKPD matematika berbasis problem solving pokok bahasan pola bilangan [Development of E-LKPD mathematics based on problem solving the subject of number patterns]. *Jurnal Pendidikan Matematika Universitas Lampung*, *9*(4), 343–359. http://dx.doi.org/10.23960/mtk/v9i4.pp343-359

Fisher, R. (1998). Thinking about thinking: Developing metacognition in children. *Early Child Development and Care*, *141*(1), 1–15. https://doi.org/10.1080/0300443981410101

Flavell, J. H. (1979). Metacognition and cognitive monitoring a new area of cognitive—developmental inquiry. *American Psychologist*, *34*(10), 906-911. https://doi.org/10.1037/0003-066X.34.10.906

Huang, O. W., Cheng, H. N., & Chan, T. W. (2007). Number jigsaw puzzle: A mathematical puzzle game for facilitating players' problem-solving strategies. In P. Zanchetta (Ed.), *First IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning (DIGITEL'07)* (pp. 130–134). IEEE. https://doi.org/10.1109/DIGITEL.2007.37

Izzati, L. R., & Mahmudi, A. (2018). The influence of metacognition in mathematical problem solving. *Journal of Physics: Conference Series, 1097*, Article 012107. https://doi.org/10.1088/1742-6596/1097/1/012107

Jacobse, A. E., & Harskamp, E. G. (2012). Towards efficient measurement of metacognition in mathematical problem solving. *Metacognition and Learning*, *7*(2), 133–149. https://doi.org/10.1007/s11409-012-9088-x

Jaleel, S. (2016). A study on the metacognitive awareness of secondary school students. *Universal Journal of Educational Research*, *4*(1), 165–172. https://doi.org/10.13189/ujer.2016.040121

Kenedi, A. K., Helsa, Y., Ariani, Y., Zainil, M., & Hendri, S. (2019). Mathematical connection of elementary school students to solve mathematical problems. *Journal on Mathematics Education*, *10*(1), 69–79. https://doi.org/10.22342/jme.10.1.5416.69-80

Kepmentdikbud [Decree of the Minister of Education and Culture]. (2020). *Salinan lampiran keputusan menteri pendidikan kebudayaan ri nomor 1177/m/2020 tentang program sekolah penggerak* [Copy of the attachment to the decree of the minister of education and culture of the republic of Indonesia number 1177/m/2020 concerning the mobilization school program]. https://bit.ly/3JjvvCx

Lestari, K. E., Utami, M. R., & Yudhanegara, M. R. (2022). Exploratory analysis on adaptive reasoning of undergraduate student in statistical inference. *International Journal of Instruction*, *15*(4), 535-554. https://doi.org/10.29333/iji.2022.15429a

Lestari, K. E., Utami, M. R., & Yudhanegara, M. R. (2023). Sequential exploratory design by performing correspondence analysis to investigate procedural fluency of undergraduate student. *AIP Conference Proceedings, 2588*, Article 050004. https://doi.org/10.1063/5.0111974

Lieban, D., Barreto, M. M., Reichenberger, S., Lavicza, Z., & Schneider, R. M. (2018). Developing mathematical and technological competencies of students through remodeling games and puzzles. In E. Torrence, B. Torrence, C. Sěquin, & K. Fenyvsi (Eds.), *Proceedings of Bridges 2018: Mathematics, Art, Music, Architecture, Education, Culture* (pp. 379-382). Tessellations Publishing. https://bit.ly/Lieban2018

Lieban, D., & Lavicza, Z. (2019, July). Dissecting a cube as a teaching strategy for enhancing students' spatial reasoning:

Combining physical and digital resources. In S. Goldstine, D. McKenna, & K. Fenyvesi (Eds.), *Proceedings of Bridges 2019: Mathematics, Art, Music, Architecture, Education, Culture* (pp. 319-326). Tessellations Publishing. https://bit.ly/Lieban2019

Liljedahl, P., Santos-Trigo, M., Malaspina, U., & Bruder, R. (2016). *Problem solving in mathematics education.* Springer. https://doi.org/10.1007/978-3-319-40730-2

Lin, C. H., & Chen, C. M. (2016). Developing spatial visualization and mental rotation with a digital puzzle game at primary school level. *Computers in Human Behavior*, *57*, 23–30. https://doi.org/10.1016/j.chb.2015.12.026

Lubis, A. B., Miaz, Y., & Putri, I. E. (2019). Influence of the guided discovery learning model on primary school students' mathematical problem-solving skills. *Mimbar Sekolah Dasar*, *6*(2), 253–266. https://doi.org/10.17509/mimbar-sd.v6i2.17984

Miles, B. M., & Huberman, M. (1994). *Qualitative data analysis*. SAGE Publications Inc.

Misu, L., & Masi, L. (2017). Comparison of metacognition awareness of male and female students based on mathematics ability in department of mathematics education of halu oleo university. *International Journal of Education and Research*, *5*(6), 43–50. https://doi.org/10.33122/ijtmer.v2i3.118

Mulyasari, D., Gunarhadi, W., & Roemintoyo, E. (2022). LKPD based on problem based learning (PBL) approach to measure mathematics literacy ability of elementary students. *International Journal of Elementary Education*, *6*(3), 393-402 https://bit.ly/Mulyasari2022

Özcan, Z. Ç. (2016). The relationship between mathematical problem-solving skills and self-regulated learning through homework behaviours, motivation, and metacognition. *International Journal of Mathematical Education in Science and Technology*, *47*(3), 408–420. https://doi.org/10.1080/0020739X.2015.1080313

Özcan, Z. Ç., & Eren Gümüş, A. (2019). A modeling study to explain mathematical problem-solving performance through metacognition, self-efficacy, motivation, and anxiety. *Australian Journal of Education*, *63*(1), 116–134. https://doi.org/10.1177/0004944119840073

Özkubat, U., & Özmen, E. R. (2021). Investigation of effects of cognitive strategies and metacognitive functions on mathematical problem-solving performance of students with or without learning disabilities. *International Electronic Journal of Elementary Education*, *13*(4), 443–456. https://doi.org/10.26822/iejee.2021.203

Ozsoy, G., & Ataman, A. (2009). The effect of metacognitive strategy training on mathematical problem solving achievement. *International Electronic Journal of Elementary Education*, *1*(2), 67–82. https://bit.ly/OzsoydanAtaman2009

Panaoura, A., Gagatsis, A., & Demetriou, A. (2009). An intervention to the metacognitive performance: Self-regulation in mathematics and mathematical modeling. *Acta Didactica Universitatis Comenianae*, *9*(9), 63–79. https://bit.ly/Panaoura2009

Phonapichat, P., Wongwanich, S., & Sujiva, S. (2014). An analysis of elementary school students' difficulties in mathematical problem solving. *Procedia - Social and Behavioral Sciences*, *116*, 3169–3174. https://doi.org/10.1016/j.sbspro.2014.01.728

Polya, G. (2004). *How to solve it: A new aspect of mathematical method* (Vol. 85). Princeton University Press. https://bit.ly/PolyaBook2004

Posamentier, A. S., & Krulik, S. (Eds.). (2009). *Problem solving in mathematics, grades 3-6: Powerful strategies to deepen understanding*. Corwin. https://bit.ly/ProblemsolvingPosamentier

Pulungan, M., Dewi Maharani, S., Ratna, E., Waty, K., Leva, M., Safitri, O., Suganda, V. A., & Husni, T. (2022). Development of e-student worksheets in the form of picture stories using live worksheets in primary schools. *Jurnal Iqra': Kajian Ilmu Pendidikan*, *7*(2), 157–167. https://doi.org/10.25217/ji.v7i2.1759

Puspita, V., & Dewi, I. P. (2021). Efektifitas E-LKPD berbasis pendekatan investigasi terhadap kemampuan berfikir kritis siswa sekolah dasar [Effectiveness of E-LKPD based on investigative approach on critical thinking ability of elementary school students]. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *5*(1), 86–96. https://doi.org/10.31004/cendekia.v5i1.456

Ramlah. (2021a, September 17). *Lkpd1 - mengidentifikasi, mengenal dan mengkonversi satuan panjang (cm - m)* [lkpd1 - identify, recognize and convert length units (cm - m). Liveworksheets. https://www.liveworksheets.com/qo2512606qd

Ramlah. (2021b, September 19). *Lkpd3 – satuan berat* [lkpd3-weight units]. Liveworksheets. https://www.liveworksheets.com/dk2521896ke

Ramlah, R., Riana, N., & Abadi, A. P. (2022). Fun math learning for elementary school students through interactive puzzle media. *Supremum Journal of Mathematics Education*, *6*(1), 25–34. https://doi.org/10.35706/sjme.v6i1.5775

Ratnayake, I., Thomas, M., & Kensington-Miller, B. (2020). Professional development for digital technology task design by secondary mathematics teachers. *ZDM - Mathematics Education*, *52*, 1423–1437. https://doi.org/10.1007/s11858-020-01180-8

Rellensmann, J., Schukajlow, S., Blomberg, J., & Leopold, C. (2022). Effects of drawing instructions and strategic knowledge on mathematical modeling performance: Mediated by the use of the drawing strategy. *Applied Cognitive Psychology*, *36*(2), 402–417. https://doi.org/10.1002/acp.3930

Roberts, T., Maiorca, C., Jackson, C., & Mohr-Schroeder, M. (2022). Integrated stem as problem-solving practices. *Investigations in Mathematics Learning*, *14*(1), 1–13. https://doi.org/10.1080/19477503.2021.2024721

Rosikhoh, D., Abdussakir, A., & Mukmin, M. I. (2022). Investigation of metacognition level of secondary school students in solving islamic-based numerical literacy. In B. K. Prahani, N. Fitriyani, Y. Mahatma, Sueb, M. F. Ubaidillah, & K. Wahyu (Eds.), *Proceedings of the International Conference on Madrasah Reform 2021 (ICMR 2021)* (pp. 18–24). Atlantis Press. https://doi.org/10.2991/assehr.k.220104.004

Santoso, F. E., Napitupulu, E. E., & Amry, Z. (2019). Metacognitive level analysis of high school students in mathematical problem-solving skill. *American Journal of Educational Research*, *7*(12), 919–924. https://doi.org/10.12691/education-7-12-4

Saroinsong, W. P., Imara, F. U., Simatupang, N. D., & Maulidiyah, E. C. (2021). The effectiveness of m-puzzle toward preschooler spatial skill. *Jurnal Ilmiah Pendidikan Prasekolah Dan Sekolah Awal*, *6*(2), 109–131. https://doi.org/10.24269/jin.v6i2.3960

Schneider, W., & Artelt, C. (2010). Metacognition and mathematics education. *ZDM -Mathematics Education*, *42*, 149–161. https://doi.org/10.1007/s11858-010-0240-2

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education*, *36*(1–2), 111–139. https://doi.org/10.1007/s11165-005-3917-8

Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology, 19,* 460-475. https://doi.org/10.1006/ceps.1994.1033

Sharma, A. (2022). Digital technologies for developing worksheets. *Learning Curve,* (12), 28-33. https://bit.ly/AnushaSharma

Solso, R. L., MacLin, M. K., & MacLin, O. H. (2005). *Cognitive psychology.* Pearson Education. https://bit.ly/Solso2005

Surya, E., Putri, F. A., & Mukhtar. (2017). Improving mathematical problem-solving ability and self-confidence of high school students through contextual learning model. *Journal on Mathematics Education, 8*(1), 85-94. https://doi.org/10.22342/jme.8.1.3324.85-94

Swartz, R., & Chang, A. (1998). *Instructional strategies for thinking classroom.* National Institute of Education. https://bit.ly/Swartz1998

Swartz, R. J., & Perkins, D. N. (1989). Teaching thinking: Issues and approaches (Revised ed.). *The practitioners' guide to teaching thinking series.* Midwest Publications.

Sword, L., & Director, G. (2005). *The power of visual thinking.* Gifted and Creative Services Australia. https://bit.ly/Sword2005

Valero, P. (2001). Social justice and mathematics education gender, class, ethnicity and the politics of schooling. *ZDM – Mathematics Education, 33*(6), 187–191. https://bit.ly/Valero2001

Whitebread, D., Bingham, S., Grau, V., Pino Pasternak, D., & Sangster, C. (2007). Development of metacognition and self-regulated learning in young children: Role of collaborative and peer-assisted learning. *Journal of Cognitive Education and Psychology*, *6*(3), 433–455. https://doi.org/10.1891/194589507787382043

Wilson, J., & Clarke, D. (2004). Towards the modelling of mathematical metacognition. *Mathematics Education Research Journal*, *16*(2), 25-48. https://doi.org/10.1007/BF03217394

Yudhanegara, M. R., & Lestari, K. E. (2019). Clustering for multi-dimensional data set: A case study on educational data. *Journal of Physics: Conference Series*, *1280*, Article 042025. https://doi.org/10.1088/1742-6596/1280/4/042025

Yusuf, I., & Widyaningsih, S. W. (2020). Implementing e-learning-based virtual laboratory media to students' metacognitive skills. *International Journal of Emerging Technologies in Learning*, *15*(5), 63–74. https://doi.org/10.3991/ijet.v15i05.1202