Using Word-problems to Promote Reading-comprehension and Problem-solving Skills : Lessons Learned from Mathematics Word-problems in Japanese Elementary Schools

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― Lessons Learned from Mathematics Word-problems in Japanese Elementary Schools ―

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文章題を通じた児童の読解力・問題解決力の促進

― 日本の小学校における算数文章題からの知見 ―

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ABSTRACT

Through an analytical review of lesson plans, classroom activities, specifically in grade 3, and the school textbook, this qualitative study examined the use of mathematics word-problems to promote reading-comprehension and problem-solving skills in a Hakodate Elementary School attached to the Hokkaido University of Education. Ten classroom teachers were also required to complete a questionnaire covering topics such as word-problem definitions and their significance, word-problem formulation, and teaching approaches to solving the word problems.

The math textbook was found to support students' reading-comprehension and problem-solving abilities because it provided word problems as a part of math activities, with several textbook components specifically focused on key elements, such as a student manual focused on solving word problems, "a reading with math" section, math sentences, and open-ended word-problems. The review of the lesson plan, teacher questionnaire, and classroom practices found that the teachers recognized that each math lesson needed to promote reading-comprehension and problem-solving skills; therefore, they set up a student-centered learning classroom, designed "problem for the day", and gave students time to learn from each other through pair or group discussions. These findings confirm that good practices of math word-problems are essential for mathematics education and to develop good problem-solving skills not only in Japan but also in other countries.

1. Introduction

1. 1. Background

Mathematics word-problems, which are part of problem-based learning (PBL) in mathematics curricula, develop creative thinking through cognitive and logical analysis. PBL is an instructional mathematics contextual learning approach that seeks to engage students, extend their understanding of mathematics concepts, and highlight the importance of mathematics as a problem-solving tool. Because PBL situates the learning in real-world problems, it promotes active, responsible learning (Hmelo-Silver, 2004) and has been found to be more effective than student-centered learning, which tends to be more focused on student activities in group or project-based discussions.

However, many countries are still using traditional mathematics education methods, which means that many learners are struggling to develop their mathematics skills. Traditional math education does not tend to recognize the importance of mathematics word-problems and focuses only on teaching mathematics concepts, with the students being required to do many math problems that do not challenge them to think critically. For example, despite the newly-designed curriculum in Indonesia encouraging teachers to move from teacher-centered learning to student-centered learning, most Indonesian math teachers do not know how to efficiently implement the math curriculum to promote student problem-solving skills, which might be one of several factors that had caused a general math-skills deficiency in Indonesian students (Hendayana, Sumar, et al., 2014).

In Japan, however, math word-problems are widely used, with international education surveys highlighting the mathematics skills excellence in Japanese students. PBL and student-centered learning, both of which develop problem-solving skills, have been built into the structure of the lessons, which has attracted attention and recognition from other countries.

1. 2. Research Question

- How do mathematics textbooks in Japan equip students with problem-solving and reading-comprehension skills to solve word-problems?
- What can be learned from Japan's mathematics classroom to promote reading-comprehension and problem-solving skills?

2. Literature Review

2. 1. Developing Reading-comprehension and Problem-solving Skills from Mathematics Word-problems

Mukuntan's (2013) mathematics thesaurus defines a word problem as "a mathematical problem that is stated in words rather than in symbols or an equation". Mathematics word problems can be divided into two main groups: real-world problems and artificial exercises that provide frameworks for the exploration of mathematical structures; both of which assist in math development (Novotna, 2000).

PBL allows students to explore and solve problem situations using whatever solution strategies they wish, which they are encouraged to share with each other. Mathematical research has found that young children are able to explore problem situations and then "invent" ways to solve the problems (Cai, 2003). Carpenter et al. (1993) cited in Cai (2003) found that 65 % of the students in their sample used an invented strategy before they were taught

standard algorithms. While invented strategies can be the basis for the initial understanding of mathematical ideas and procedures, students also should be guided to develop efficient strategies.

Pedagogically, conducting mathematics lessons using word problems develops conceptual and procedural knowledge of a topic, reduces any misconceptions, and builds understanding from a state of having little understanding to mastery. Mathematical word-problem instructional strategies enable students to connect what they are learning to the knowledge they already possess and eliminate any misconceptions they may have developed (Carpenter, et al., 1988).

Reading-comprehension skills, however, are necessary to successfully solve word-problems. Vilenius-Tuohima, et.al (2008) found that math word-problem performances were strongly related to reading-comprehension skills, with fluent technical reading abilities increasing the ability to solve math word problems. However, even after controlling for the level of technical reading involved, the math word-problem performances were still found to be closely related to reading comprehension, suggesting that both skills are needed to promote reasoning abilities.

2．2．Mathematics Education in Japan

Japan's Course of Study (2018) by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) states that the mathematics education goal is to develop three main mathematical abilities.

1) Knowledge and Skill
   To understand the basic concepts and properties of quantities and figures, etc., and to acquire the skills to mathematize, interpret, express and process events mathematically.
2) Thinking, Judgment, Expression, etc.
   To nurture the ability to examine events logically, to discover the properties of quantities and figures and to consider them comprehensively and developmentally, and to express events concisely, clearly, and accurately using mathematical expressions.
3) To cultivate an attitude of enjoyment toward mathematical activities, a persistence in thinking about the merits of mathematics, an attitude toward applying mathematics to life and learning, and an attitude toward evaluating and improving problem-solving skills.

The subject matter or curriculum teaching approaches and theories in Japan are the product of approximately a hundred years of lesson studies. Isoda (2010) claimed that Japanese lesson studies began with the observation of whole classroom teaching as tutorial teaching methods to understand the teaching of knowing how-to. The first known lesson-study guidebook for teachers in Japan included the establishment of a teaching approach that involved "questioning."

The Japanese math curriculum encourages teachers to promote student-centered learning to involve them in the mathematical activities to derive meaning, that is, mathematics PBL requires the students to actively solve the problems. Hmelo-Silver (2004) found that when self-directed students manage their learning goals and strategies when seeking to solve ill-structured PBL problems (those without a single correct solution), they are also acquiring the skills needed for lifelong learning. Table 1 indicates the differences between standard or conventional lessons and problem-solving

Table 1 Differences between teacher-centered lessons and student-centered lessons

Standard Lesson	Problem-solving Lesson
Teacher as Provider	Teacher as Facilitator
Learner as Recipient	Learner as Main Actor
Teacher-centered	Student-centered
One direction flow of information	Several-directions
Effective for explanations	Effective for mutual learning

lessons.

Stigler and Perry (1988) observed that to facilitate coherence, Japanese math lessons tended to devote an entire forty-minute class to solving only one or two problems. In such a lesson, students might discuss the problem features, solve the problem using alternative methods, discuss and evaluate alternative solution strategies, model the problems using manipulatives, and so on. Japanese teachers tell the students that it is the problem solving that matters, not simply getting the correct answer. Therefore, Japanese teachers often try to slow their students down by asking them to think about the problem, develop a/some solutions, and then discuss their thoughts with the class.

The new curriculum guidelines scheduled to be implemented for elementary and junior high schools from 2020 school year, indicate that the ministry is seeking to improve cross-curricular language activities and further develop student abilities to solve problems. A word-problem example is shown in Figure 1. The Education Ministry also plans to upgrade Japanese-language classes to require students to read various texts, and discuss and summarize the content (*Japanese 15-Year-Olds Rank High in Math, Sciences, but Reading down: PISA Exam*, 2019).

3. Methodology

3. 1. Mathematics Textbook Analysis

The main focus of this research was to acquire an understanding of how the widely used school textbooks in public elementary

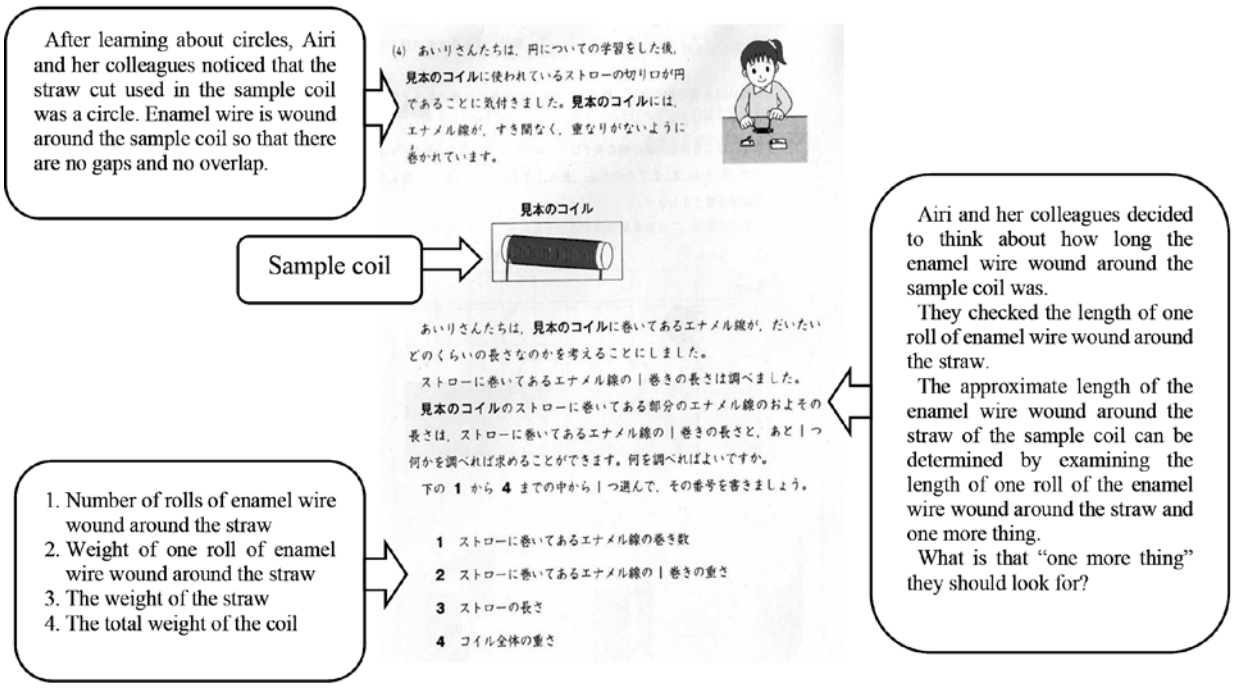


Fig. 1 Example of a 6th grade math word problems

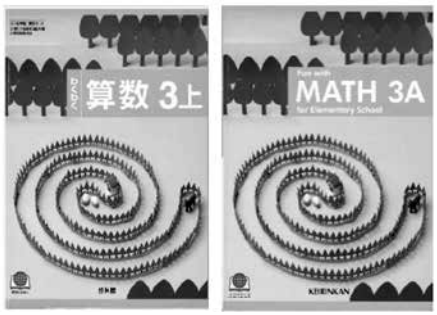


Fig. 2 Sample math textbooks

schools in Hakodate assisted the students with the math word problems and contributed to their reading comprehension and problem-solving skills. The textbooks are produced in both Japanese and English, with 11 textbooks for each language from grade 1 to grade 6 and with each grade divided into A and B books (Fig. 2). The analysis comprised how the textbooks addressed the word problems and the associated study steps, the types of word-problem presented, and the reading comprehension and problem-solving student learning goals.

3．2．Questionnaire Analysis

Ten classroom-teachers (grade 1-6) from the Hakodate Elementary School attached to the Hokkaido University of Education were asked to complete a questionnaire related to their teaching plans and motives. Points of the question are as follows:

- How do you define the concept of a mathematics word-problem?
- In what topic do you think it is useful to start dealing with word-problem? (Give rank to options below)
  - ( ) Number and Calculation
  - ( ) Figures
  - ( ) Measurement
  - ( ) Change and Relation
  - ( ) Utilization of Data
- What source do you use to formulate word-problem of the day for math lesson? (Give rank with number to options below)
  - ( ) Textbooks
  - ( ) Teacher's manual
  - ( ) Internet
  - ( ) Others ....
- How long do you usually spend to formulate word-problem for a math lesson? (Checklist one of the options below)
  - ( ) Less than 30 minutes
  - ( ) 30 minutes up to one hour
  - ( ) more than one hour
  - ( ) Others ....
- What steps in solving word-problem do you consider indispensable?
- How do you make pupils aware of these steps?
- Do you face any problem or challenge in conducting math lesson with word-problem? If yes, please explain the details and the solutions!

3．3．Lesson Analysis

Math lessons and the teacher-student lesson-study interactions specifically in grade 3, at the public Hakodate Elementary School attached to the Hokkaido University of Education were observed from June to December 2020. Lesson-studies have been widely used in Japan to maintain mathematics education quality, for which real classroom-interactions during math lessons are observed and analyzed by peer teachers and instructors and supervisors from the universities (Nagasaki, 2007). Lesson-study reports detail the teacher-pupil interactions, learning conditions, lesson topics, and give an analysis of the lesson conducted. Each presented lesson also comes with a lesson plan, as exemplified in Fig. 3.

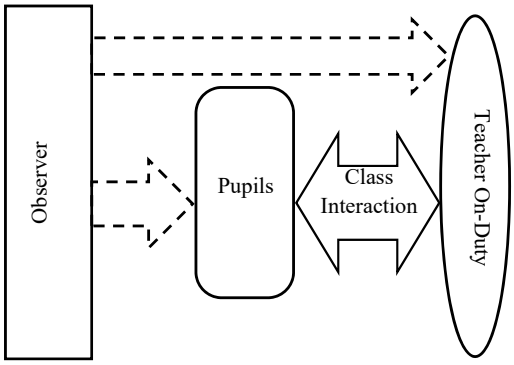


Fig. 3 Lesson Observation through Lesson Study

4. Findings and Discussion

4. 1. Word Problems in the Japanese Textbooks

There are five mathematics principles for elementary school Japan's mathematics lessons; (a) numbers and calculation; (b) figures; (c) measurement; (d) change and relationships; and (e) data utilization; each of which are included in the school textbooks and each of which has related word problems ranging in context and complexity. As one of the student learning aids, the textbooks are well-designed to meet the required needs, and more importantly, to promote critical thinking and problem-solving skills. Novotna (2000) claimed that student beliefs about math word problems were mainly based on the support provided by their textbooks to develop superficial and artificial solving strategies to solve school word problems.

The guide to using the textbooks (Table 2), which was designed to assist the students develop the abilities to solve word problems, gives a substantial introduction to the textbook and provides a guide that outlines several main steps for the math lesson flow to harmonize the math classroom routines. Polya (1973) identified four main steps to successfully solve word problems: understanding the problem; devising plans; carrying out the plan; and looking back at the results obtained. The guidance or study step pages are included in all textbooks from grades 2 to 6.

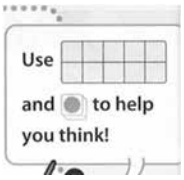
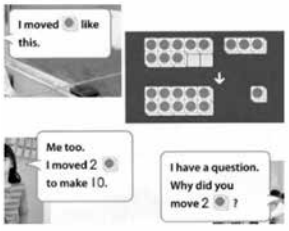
a. "What kind of problem is it?"

To encourage critical and analytical thinking to solve the problem, students must clarify what they learned and organize what they are going to do.

b. "Think on your own!"

Students are again asked to determine the goal, and comprehend and convert the word problem into a mathematical word or equation and also use pictures and diagrams to visualize the math concept, which enables them to do the calculations or to make

Table 2 Example of how to solve word problems

Grade	Study Steps			
	"What kind of problem is it?"	"Think on your own!"	"Let's talk about it"	"Check and Review"
2	*There are eight parked cars. Three more cars come. How many cars are there in all?* **Goal: the number of cars increases so we add!** Think about and explain how to calculate the math sentence! **8+3**	"How many more do we need to make 10?" 		"Now I know that I can solve any math sentence by making 10" "9+4=....?"

decision.

c. "Let's talk about it!"

Students are encouraged to share and summarize their ideas freely, state them clearly, listen to the ideas of others, and compare them to their own ideas. This is where the learning environment develops even further as it helps develop team-work and listening skills.

d. "Check and review!"

To encourage students to apply the same knowledge to other problems as well as having them practicing their current knowledge. They can also put into practice the good ideas of their classmates.

Using open-ended problems, these study steps cultivate the divergent thinking typical of Japanese mathematics classes, with the *Let's talk about it* step in particular encouraging students to come up with their own solutions. Kwon et al. (2006) claimed that unlike many traditional classes that focus on closed problems, open-ended problems with diverse answers and problem-solving strategies improve divergent thinking and are also effective in cultivating creative problem-solving abilities. Table 3 gives an example of open-ended textbook problems.

A designated topic taught as part of the mathematics curriculum in Japan is *Reading with Math* and *Math Sentence* which have been found to contribute to developing math word-problem solving skills. As solving word problems requires a certain degree of literacy, Fuentes (1998) cited in Clements (2008) claimed that to understand the math text, students need to improve their reading comprehension, which can be achieved by

Table 3 Example of word-problems with open-ended approach in textbook.

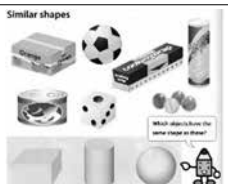
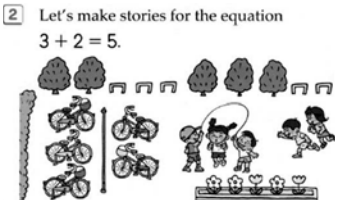
Grade	Topic	Example of word problem
1	Various Shapes	Which objects have the same shapes as these? 
	Addition	Let's make stories for the equation 3 + 2 = 5 
2	Tables, Graphs, and Clocks	Look around you. Where can you find more clocks?
	Multiplication Tables	Look around you. Make some multiplication problems based on what you see. Make question cards and share them with the class.
3	Time and Distance	Let's measure the perimeter of a tree in your schoolyard. You can measure it with a measuring tape.
4	Properties of Division	Use the properties of division to make various division problems with the same answer as 80 ÷ 20
5	Integers	Find several pairs of numbers that only have 1 as a common factor.
6	Enlarging and Reducing Geometrical Figures/Figuring out different events	Daifuku cakes are sold in boxes of 2 and 3. You need to buy 35 cakes for the youth group. How many of each box should you buy?

Table 4 Example of word-problems in "Reading with Math" Section

Grade/Topic	Passage of "Reading with Math"	Example of related word-problem
1 Numbers up to 20	Momoko's Diary July 18, Sunny I checked the morning glories at school this morning. My plant had six flowers. Takumi's plant had four flowers. Misaki's plant had three flowers. Misaki smiled and said, "Every flower is beautiful."	How many flowers do Momoko and Takumi have in all? a. How many flowers does Momoko have? b. How many flowers does Takumi have? c. Write an equation and solve it.
4 Line Graphs	Let's conserve water! Yuri wanted to know how much water she uses in daily life and how she uses it. To find out, she collected the documents below. 	Yuri said that her 4-person family uses more water if each person takes a 3-minute shower than if they all share the same bathwater. Is she correct? Answer with "correct" or "not correct." Explain the reason for your choice by using words and math sentence.

Table 5 Example of word-problems in Math-Sentence Section

Grade	Example of how to express math sentence	Example of exercise
4A Math Sentences and Calculation order	You buy a 180-yen juice and a 90-yen donut with 500 yen. Write a math sentence to calculate the change. Amount paid−cost = change 500 − (180 + 90) = 230 **"When a math sentence uses (), do the calculation inside the () first"**	The rows of seats on the bullet train seat two people on one side of the aisle and three people on the other. How many rows of seats are needed to 65 seat people?

giving the students a great deal of experience in reading word problems and translating their meaning into numbers and symbols and vice versa. The *Reading with Math* and *Math Sentence* examples in the textbook are respectively shown in Tables 4 and 5.

The *Reading with Math* section includes interesting passages with various mathematical numbers and concepts inserted. To develop critical thinking and problem solving, the complexities of the passages increase with the students' age, and beginning in grade 4, the related word-problems in *Reading with Math* also include another question type that asks the students' opinions about "correct" or "incorrect" decisions. The "Math Sentence" teaches students to decode the word problems into numbers or math calculations to solve the problem, with the problems also teaching them how to relate mathematical concepts to their daily lives.

Clements (1980) as cited in Mukuntan (2013) used Newman's Error Analysis Model and found that 66.67 % of the errors made when attempting to solve word problems occurred in the reading, comprehension, and transformation stages (the first three stages), that is, before the students performed any calculations. Mukuntan (2013) also concluded that the reading and comprehension stages were related to language knowledge. In Japan, as language and mathematics are taught by the same teacher, it is vital that the teacher prepare the students to learn mathematics through the language lessons, with the *Reading with Math*

section in the math textbook serving to assist both the teacher and the student when encountering word problems.

4. 2. Presenting Word-Problems

As claimed by Takahashi (2006), Japanese structured problem solving was built on a firm foundation that emphasized story problems for mathematics teaching and learning. Historically, Japanese mathematics teaching and learning has been focused on developing mathematical thinking skills using a variety of story problems. However, the delivery relies heavily on the teacher's pedagogical content knowledge and the implementation of PBL before introducing the word problems and solution strategies. Therefore, the "why" behind the one or two clearly-stated word-problems presented in the class are based on elaborate lesson plans. When asked how they formulated the word problems, the teachers mostly answered that the textbook was the main source, as well as the teacher manual, the internet, and other sources, with the time taken to plan the day's problem generally being less than 30 minutes (eight teachers) or between 30 minutes and an hour.

When asked which domain was best for using word problems, nine of the ten teachers believed it was useful to introduce the lesson using word problems when teaching *Numbers and Calculations*, followed by *Change and Relationships*, *Utilization of Data*, *Measurement*, and *Figures and Shapes*. Therefore, this research focused on an analysis of the word problems and lesson plans in the *Number and Calculations* domain. Table 6 gives an example of the lesson flow for grade 3 for the topic *Division with remainder*. First, to improve their reading comprehension, it is expected that the students are able to understand the math text. Fuentes (1998) cited in Clements (2008) claimed that reading comprehension could be improved by giving the students a lot of experience in reading word problems and translating the meaning into numbers and symbols and vice versa.

The importance of presenting word problems in each mathematics lesson was reflected in the teachers' responses to the questionnaire. For example, when asked how they defined mathematics word-problems, some teachers answered; "*Problems requiring students to read the problem, visualize and conceptualize it, and think mathematically about what the problem is asking enables the students to nurture and trigger their thinking abilities*"; which highlighted the crucial role that the word problems had in improving the students' problem-solving skills/ abilities. Some teachers also responded; "*Problems requiring the students to utilize their previous knowledge so that they can comprehend the question and express it through equations, formulations, diagrams, graphs, figures or even written opinion.*" The lesson plan shown in Table 6 also emphasizes the importance of grasping and formulating a mathematical way of thinking to solve the problem described in the problem scene.

The following lesson description from the observation and lesson analysis was for lesson 7 (Table 6). The lesson emphasized that the mathematics required was not just knowing or memorizing a mathematics formula, but required a comprehension of the relationships between the mathematical concept and real-life problems, which was also built into each problem of the day. Table 7 shows the first stage of the math-lesson in the lesson plan called *Presenting the problem*, in which the teacher mentioned the daily life (utilization)

Table 6 Lesson flow and student activities in math class

Problem for the Day							
Lesson 1	**Lesson 2**	**Lesson 3**	**Lesson 4**	**Lesson 5**	**Lesson 6**	**Lesson 7**	**Lesson 8**
There are 14 jellies. If one person takes three jellies, how many people can get a jelly?		There are 13 candies. If you put four pieces in one bag, how many bags can you make and how many remainders are there?	There are 16 flower seeds. They will be distributed to three people, so how many flower seeds does one person receive and how many flower seeds are left over?	There are 23 sheets of colored paper. If you divide them into six sheets for each person, how many people will get the paper and how many papers will be left?	(Calculation practice)	There are 23 cakes that will be distributed to boxes, each of which takes four cakes. How many boxes will be needed? We are going to make a car toy with four tires. If there are 30 tires, how many toys can be made?	Work on proficiency problems.
Flow of the Lesson							
・Use concrete object to operate and give a perspective of the solution ・Continuing from the previous lesson, we will announce each idea and confirm the solution. ・Acknowledging the meaning of "remainder" ・Address the word problem		・Grasp and formulate the relationship between quantities from problem scene. ・Observe the magnitude relationship between remainder and divisor	・Grasp and formulate the relationship between quantities from the problem scene. ・Think about how to solve the problem. ・Address how pupils come up with their solutions.	・Grasp and formulate the relationship between quantities from the problem scene ・Consider how to confirm the solution of the division method including when it is not divisible ・Address how pupils come up with their solutions	Practice calculation and check the answers	・Grasp and formulate the relationship between quantities from the problem scene. ・In the calculation, it is five remainder 3 but discuss whether the answer can be 6 or 7 as the answer.	Work on proficiency problem

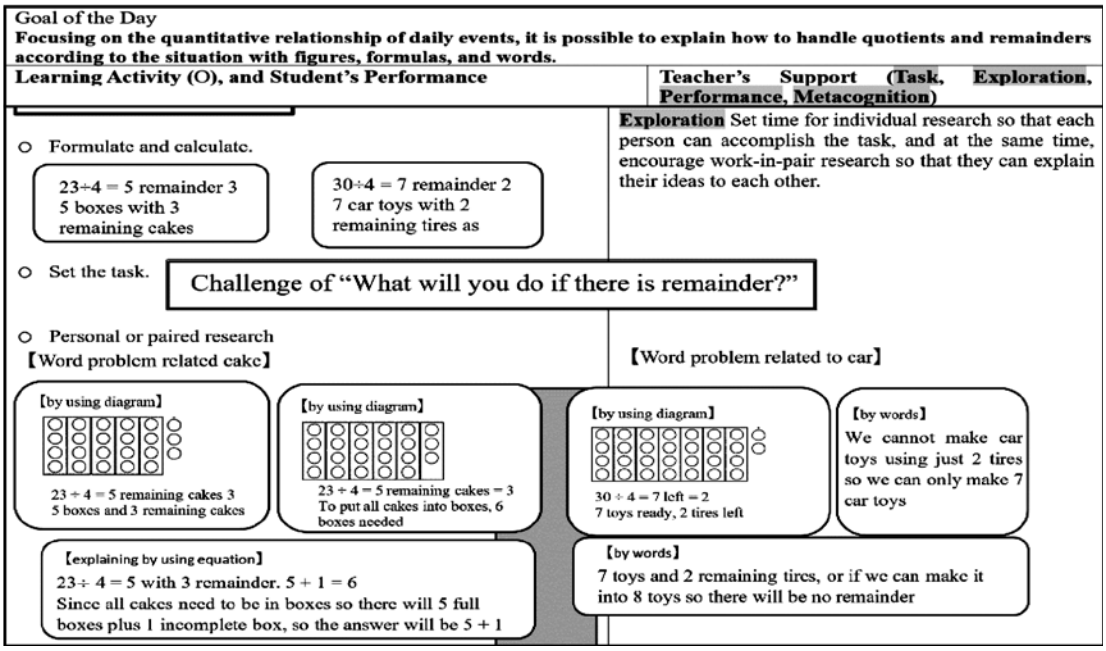
Table 7 Example for "Presenting the problem for the day" stage in the lesson plan

Goal of the Day **Focusing on the quantitative relationship of daily events, it is possible to explain how to handle quotients and remainders according to the situation with figures, formulas, and words.**	
Learning Activity (O), and Student's Performance	**Teacher's Support (Task, Exploration, Performance, Metacognition)**
○ Understand the problem scene. There are 23 cakes that will be distributed to boxes which each box takes 4 cakes. How many boxes will be needed? We are going to make a car toy with 4 tires. If there are 30 tires, how many toys can be made then?	**Task** In order to connect with daily life and raise awareness of the task, take a friend who is in trouble as an example and present the problem carefully with dialogue.

association as part of student's learning materials.

The second stage was a math-lesson called *Independent Problem-solving* (Table 8). The main lesson task was often written in a highlighted box to excite student interest toward the problem; in this case, "What will you do if there is remainder?" which required the students to think about how to solve the problems individually. Polya (1973) claimed that in the first stage of solving math problems, students needed to both understand the

Table 8 Example of "Independent Problem-solving" in lesson plan



problem and desire a solution. The teacher outlined the indispensable steps in solving the word problem as follows; "*understanding the passage, finding the keywords or substantial numbers according to the passage,*" "*clarifying the situation or the problem being asked or finding the goal and seeing how your previous knowledge related to it,*" "*organizing the substantial points to make a solution plan,*" "*visualizing the problem and properly formulating and calculating,*" or "*finding various solution methods.*"

Some of teacher's approaches to making the students aware of these word-problem solution steps was "*facilitating student understanding as to what the problem is asking for, giving instructions to underline the clues, hints, key points or what is being asked from the problem*" or "*have students to conceptualize the substantial question from the problem, especially for first graders, to make them visualize the problem through manipulatives or their psychomotor abilities (hand movements).*" Some teachers used practice questions such as "*What is being asked*", "*What is the unknown*", "*Can you imagine the situation from the text?*" or "*What kind of solution do you have?*". Some teachers also stated that they reminded the students whenever they overlooked crucial information from the word problems, or related the math concepts to the student's life. In the lesson plan, the teacher often marked this second stage by predicting the student responses or the various solution methods, that is, they sought to anticipate the students' responses to explore and develop the lesson more deeply. Most students had a good grasp of the concept of division with remainder and were able to freely express their ideas about the problem (Fig. 4).

In the second stage, the teacher asked the students to discuss their individual solutions in groups to explore other solutions and compare their own. Clements (2008), found that confidence was important to becoming a better problem solver and that the confidence gained through solving a problem correctly gave students more confidence when working in groups because they began to trust one another.

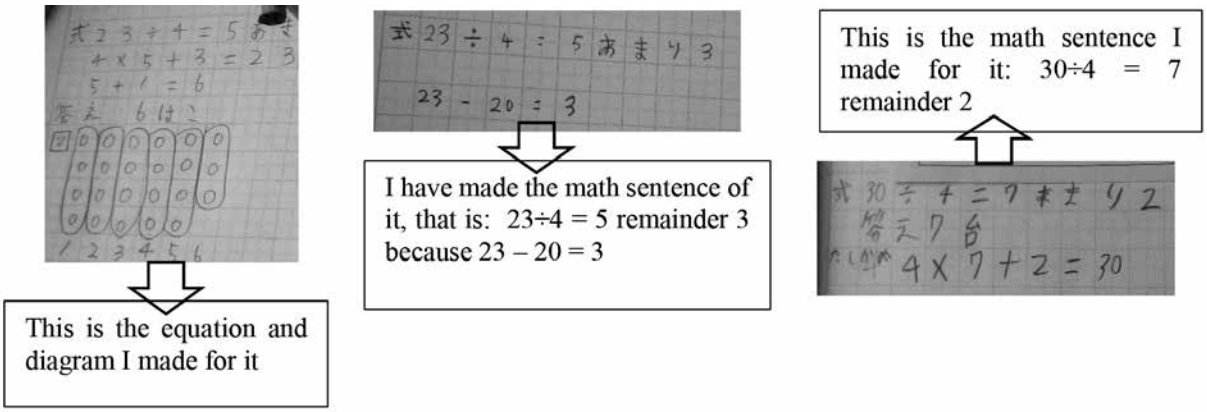


Fig. 4 Student responses

As this stage developed, the teacher elicited the representative ideas to the whole class and and encouraged further discussion by throwing questions to challenge the students' solutions, which led to the third stage; *comparing and discussing* (Table 9).

This lesson emphasized that mathematics was not only about knowing or memorizing mathematics formula but required a comprehension of the relationships between the mathematical concepts and real-life problems. The teacher deepened the students' critical thinking skills by questioning their comprehension regarding the *remainder* in the division problems by asking "*how do we deal with the remainder? should we round it to one or not*" (Fig. 5). The students were then faced with a different situation from the first word problem. Based on the mathematical concept, there would normally be remainder; however, if they looked at the problem as one related to daily-life, people would put the remaining three cakes in a box; that is, there would be no remaining cakes or remainder. Most students

Table 9 Example of "Comparing and Discussing" stage in the lesson plan

Goal of the Day **Focusing on the quantitative relationship of daily events, it is possible to explain how to handle quotients and remainders according to the situation with figures, formulas, and words.**	
Learning Activity (O), and Student's Performance	**Teacher's Support (Task, Exploration, Performance, Metacognition)**
○ Raise and challenge students' critical thinking. why do you still have to prepare the box for the remaining cakes but you do not do the same for the remaining tires? Since we have to put all cakes into boxes, so we still need box for those three remaining cakes We could not make another car toy using only 2 tires Try to round the remainder into 1 (whole number)! How we deal with remainder (whether we have to round it into 1 or not) is depending on situation and problem type.	**Performance** Have teacher to bring out and present representative ideas so that the problem can be investigated as a classroom discussion. ✓ In order to enhance individual pursuits, teachers will directly support how to draw diagrams as necessary, so each of students' ideas could be delivered well to the entire class. **Meta** Encourage students to organize their own thoughts, communicate and compare it with their peers. ❖ **You can explain how to handle quotients and remainders according to the situation with figures/diagrams, formulas, and words.**

Fig. 5 Teacher support using manipulatives in the classroom discussion

answered "*5 boxes with 3 remaining cakes*," but some students also came up with "*(5 + 1) boxes*" meaning five complete boxes and one incomplete box, a solution that was agreed to by the other students. Moving on to the second problem, the teacher again asked the students to think about a solution to the remainder. While some students argued that both problems could use the same concept, others claimed that it was not possible to turn the tire into the same toy but they could probably still turn them into another vehicle such as a bicycle or motor-cycle toy that only used two tires.

In the last stage, the teacher strengthened the lesson learned by the students by asking them how they should conclude the lesson, as shown in the lesson plan (Table 10). One student said; "*We can still use remainder for*

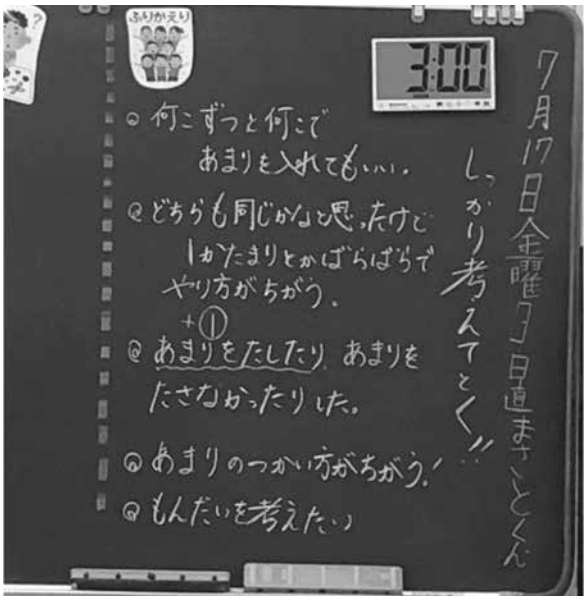


Fig. 6 Summary of the math lesson

certain things," and another stated, "*The use of the remainder depends on the type of problem.*" The teacher then wrote down all the student statements (Figure 6) for all the students to see and so the students could take notes. Then, the teacher restated these summaries to end the class. Toshiakira (2016) stated that in the "summing-up by the teacher" stage, the teacher should mention something about which strategy was the most sophisticated and why. Therefore, teachers need to discuss the reasonableness of the solutions as foreshadowed in the lesson plan. Eckman (2008) claimed that when students are summarizing, their understanding becomes more visible, which can give students the chance

Table 10 Example of the "Summing-up" stage in lesson plan

Goal of the Day **Focusing on the quantitative relationship of daily events, it is possible to explain how to handle quotients and remainders according to the situation with figures, formulas, and words.**	
Learning Activity (O), and Student's Performance	**Teacher's Support (Task, Exploration, Performance, Metacognition)**
○ [Today's realization] Conclude what I understand, today. There are times I have to turn remainder into 1 whole number but there are times not I understand that sometimes we have to consider to round the remainder into 1 or just to leave it that way.	✓ Exchange what you know and what you notice, and share the aim of this time. ✓ If there is a student who is confused about how to handle the quotient or the remainder, encourage them to show it in a diagram.

to understand concepts that they had not thought of before by listening to their peers' explanations.

Presenting word-problems in a class has its own difficulties. However, five of the teachers claimed that there were no real problems, whereas others revealed some issues often occurred as well as their strategies for handling them, such as "*students having difficulties understanding the subject of the problems or to doing the calculations according to the problems,*" "*students having problems visualizing the word problem,*" or "*individual differences in student knowledge that might cause a different understanding of the problem.*" The useful strategies recommended by some teachers for these issues were: "helping students reflect on previous problems to solve current problems"; and "encouraging students to use diagrams, pictures, or symbols." Some teachers also mentioned the need to familiarize students with the problem scenes by training the students to solve a wider range of problems, relating the problems to the students' daily lives, and adjusting the difficulty levels of the word-problems based on the students' abilities, which indicated that the teachers needed to be aware of the students' pre-knowledge.

5. Conclusion

Using word problems at elementary schools in Japan to present math concepts encourages critical thinking, and strengthens reading comprehension and mathematics problem-solving skills. As shown in this paper from the analysis of specific elementary math class lesson plans, lesson observations, and teacher feedback from a focused questionnaire, using word problems to elucidate math concepts should be introduced in countries struggling to improve their mathematics education systems, such as Indonesia. This research confirmed that the mathematical word-problem approach can bridge the gap between mathematical concepts and daily life, and allow students to understand the benefits of learning mathematics. Therefore, introducing a problem-solving approach as a part of Indonesian mathematics education reforms could develop better problem solvers.

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