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Learning Design for Understanding the Concepts of Addition and Subtraction for ADHD Students Using the PMRI Approach

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Abstract

The ability to understand the concept of addition and subtraction is fundamental to all students, including students with Attention Deficit and Hyperactivity Disorder (ADHD). This study aims to produce a learning trajectory for understanding the concept of adding and subtracting whole numbers for students with ADHD using the PMRI approach. The subjects in this study were Grade 1 students with ADHD at the inclusive school or SDN 30 Palembang. The research method used was the design research method. The present research was conducted in three stages, namely the preparation stage, the two-cycle experimental design stage, (cycle I: pilot experiment, cycle II: teaching experiment), and the retrospective analysis stage. Data collection was carried out by an observation, interviews, a pre-test, written tests, documentation, and field notes. The results of the research showed that the learning activities designed could help students understand the concepts of adding and subtracting whole numbers. Some indicators of conceptual understanding that appeared in the students were the students' abilities to classify objects according to certain characteristics, present concepts in the form of mathematical representations or images, develop the necessary and sufficient conditions for a concept, utilize and choose certain procedures or operations, and apply problem-solving concepts or algorithms. Eventually, a learning trajectory involving two activities using unique contexts of the city of Palembang supports understanding the concept of addition and subtraction.

Keywords: Addition, ADHD, Conceptual Understanding, Design Research, PMRI, Subtraction

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INTRODUCTION

Based on the Regulation of the Minister of Education and Culture No 37 of 2018, one of the essential competencies that students must achieve for mathematics in grade I of elementary schools is to explain, perform, and complete additions and subtractions involving whole numbers. Addition and subtraction are basic abilities that students must master to learn multiplication, another fundamental concept that supports mathematical concepts such as division, fractions, and percentage (Nuraida & Putri, 2019). According to Musser et al. (2005), addition can be a combination of two or more numbers. The addition of these integers can be written as follows: "Suppose a and b are any two integers., If A and B are mutually exclusive sets with $a = n(A)$ and $b = n(B)$, then $a + b = n(A \cup B)$". Meanwhile, subtraction is the reverse operation of the addition of integers (Musser et al., 2005). In subtraction of integers can be written as follows: "Suppose a and b are arbitrary integers, each of A and B is a set, and $B \subseteq A$., then, $a - b = n(A - B)$."

Mathematics is essential in education and current technological developments (Arifin & Herman, 2018). One of the goals of learning mathematics is to understand concepts (Kartika, 2018). According to Lestari (2018), conceptual understanding is the competence students demonstrate in carrying out procedures (algorithms) flexibly, accurately, efficiently, and precisely. Conceptual understanding refers

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to understanding relation to ideas that allows students to learn new ideas by connecting old ideas that the students already know. Therefore, it is essential that all students, both regular and students with special needs, master understanding mathematical concepts (Wibowo et al., 2022).

Children with special needs experience limited/exceptional physical, mental-intellectual, social, and emotional conditions that significantly influence their growth & development processes compared to other children of their age, as stated in a Regulation of the Minister of Women Empowerment and Child Protection 2011. Children with ADHD are among those within the category of children with special needs ADHD is a condition in which a child exhibits a persistent pattern of inattention, hyperactivity, and impulsivity that appears more frequently than is usually observed in other children. Within the same developmental phase (Muna et al., 2022). Children with ADHD are usually described as overly active (hyperactive), impulsive, and havinge difficulty paying attention/concentrating (Mirnawati & Amka, 2019; Marlina & Kusumastuti, 2019). Due to their extreme activeness and impulsivity, students with ADHD are easily distracted, which makes it difficult for them to concentrate during classes. Mirnawati and Amka (2019) described ADHD as being inclusive of brain dysfunction, where individuals experience difficulties controlling impulses, inhibiting behavior, and resisting distraction. If it happens to a student, it can cause the student various behavioral, social, and learning difficulties (Susiaty et al., 2021).

According to Rokhim (2017), teachers could maintain the attention of students with ADHD by introducing various topic in way that attracts their attention and by emphasizinge the importance of these topics in their daily lives. In teaching addition and subtraction, teachers can use the Pendekatan Matematika Realistik Indonesia (PMRI) approach in the learning process. It is an approach in mathematics learning that focuses on student interactivity and contributions in learning, namely Realistic Mathematics Education of Indonesia or known as Pendekatan Matematika Realistik Indonesia (PMRI) (Putri, 2011; Zulkardi & Putri, 2010; Zulkardi, 2002). It uses real-world contexts as a starting point in learning mathematics (Fauziah & Putri, 2022; Zulkardi, & Putri, 2019). Students may gain an understanding of abstract mathematical concepts when contexts related to the real world are used. Saputri & Zulkardi (2020) also stated, that one of the approaches that can help students connect abstract mathematical concepts with problems from the real world is to use the PMRI approach.

Hakki and Wallace (2022) previously investigated the obstacles face by students with LD (Learning Disabilities), ADHD, and Autism in learning statistics. Mariyah et al. (2017) developed some teaching aids to improve the mathematics learning abilities of students with ADHD. Meanwhile, Marlina et al. (2018) analyzed the mathematics learning process students with ADHD were going through in inclusive schools. However, studies focusing on mathematics learning in the concepts of adding and subtracting integers among students with ADHD, especially one that uses unique contexts of the city of Palembang, have been rare. Using context in learning can help students connect abstract mathematical concepts with things close to them in their daily lives. This research focuses on addition and subtraction learning using unique contexts of the city of Palembang among students with ADHD.

This research aims to produce a learning trajectory for the materials of adding and subtracting whole numbers with the PMRI approach to improve the conceptual understanding of students with ADHD.

METHODS

The current research employed the validation study type design research method. This study aims to produce a learning trajectory for understanding the concept of adding and subtracting integers for students with ADHD. The subjects in this study were Grade 1 ADHD student at the inclusive school SD Negeri 30 Palembang for the 2022/2023 academic year.

This research is design research type validation studies consisted of three stages (Gravemeijer & Cobb, 2006). The first stage was the preparation stage, in which the experiment was prepared. This stage consisted of a literature review and the design of a Hypothetical Learning Trajectory (HLT). An HLT contains learning activities in the form of alleged strategies and students' thoughts that develop during the learning process, in this case concerning the concepts of adding and subtracting whole numbers. The second stage was the experimental design stage. This stage contained two cycles, the first of which pilot experiment was when an HLT test was designed for students with ADHD. The pilot experiment was intended to collect data for adjusting and revising the HLT, which would later be used in the second experimental learning.

The HLT that was designed and improved after the trial was subsequently tested in an actual class, which was composed of the subjects of the study. The third stage was a retrospective analysis. The data obtained from the teaching experiment stage were analyzed retrospectively in this stage by comparing the HLT that was developed with the actual learning. Data collection was carried out by observation, interviews, a pre-test, written tests, documentation, and field notes.

The aim of the observation before cycle 1 was to obtain an overview of the social norms applied in the mathematics class, the teaching methods used by the teacher, the class organization, the class rules, students' works, and the time allocation. In this research, interviews were conducted with the teachers, parents, students, and psychologists. Interviews were conducted with the teachers to find out students' conditions, suitability of the contexts used, suitability of the materials, time, and their opinions about the HLT that was designed. Then, the researchers interviewed parents to find out students' conditions at home regarding their study habits and interest in studying. Next, the researchers interviewed students regarding their understanding of the concepts of adding and subtracting whole numbers. Finally, the researchers interviewed psychologists to find out the suitability of the contexts used, the suitability of the materials, the students' conditions, and student's interest in learning. The pre-test was carried out to determine the starting point of abilities of the students, who were subjects of the research, in the teaching experiment and what the students had to learn. Written tests were given to students with ADHD at the HLT trial stage in cycle 1 and cycle 2. The purpose of these tests was not to compare but to determine students' initial abilities, and strategies in solving mathematical problems

regarding the concepts of addition and subtraction of whole numbers. Lastly, documentation aimed to record the strategies used by students during learning activities. Documentation was carried out in video form so that student strategies could be analyzed and measured. Field notes were carried out as a record of researchers during learning, so that it can be taken into consideration to compare the HLT that has been designed with the actual student learning trajectory.

RESULTS AND DISCUSSION

This study produced a learning trajectory for understanding the concepts of addition and subtraction of whole numbers using unique contexts of the city of Palembang. Before obtaining a learning trajectory, researchers first developed a Hypothetical Learning Trajectory (HLT). The HLT developed in this study was designed for ADHD students using unique contexts of the city of Palembang and the PMRI approach. The contexts of the city of Palembang were chosen because they were familiar to students. Andreescu et al. (2020) revealed that familiar contexts of problems would make students increasingly connected to mathematical materials. The use of suitable contexts will rase,, students' awareness that mathematics is a human activity in their immediate surrounding, enable them to learn mathematical principles and concepts naturally through their activities, and increase their interest, knowledge and positive attitudes towards mathematics (Lee et al., 2020).

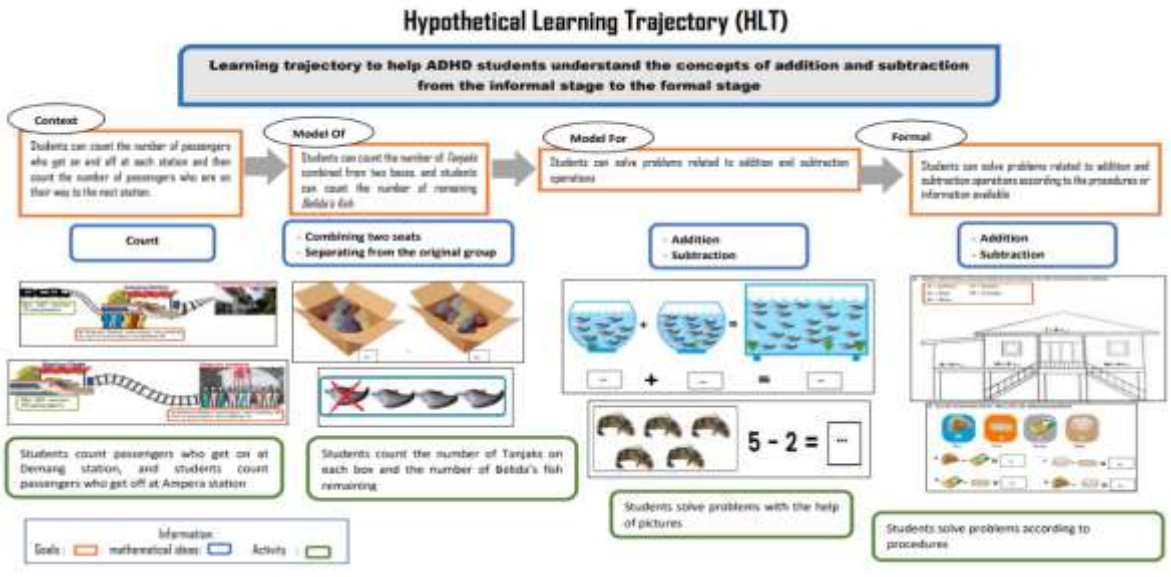


Figure 1. The HLT on addition and subtraction using the PMRI approach

Figure 1 is an HLT developed in the present research on addition and subtraction of whole numbers. The HLT was designed to contain two activities that were used in four meetings. In the first meeting, students conducted activity 1. Using the contexts LRT, *tanjak*, *belida* fish, and *limas* house of the city of Palembang. This activity aimed to enable students to understand the concept of adding whole numbers.

Figure 2. Students when demonstrating the condition of passengers on the LRT

The first meeting began with students demonstrating in front of the class the condition of passengers who got on the LRT (Light Rail Transit) at a station, but one of them got off. Figure 2, is a picture of students engaging in this activity. After several times the students demonstrated the condition of passengers taking the LRT in rotation. The model teacher gave the students a wide range of activities regarding the addition material. From the results of activity one, it is known that students could conclude the concept of addition with their sentences. The following is a snippet of student answers in activity 1.

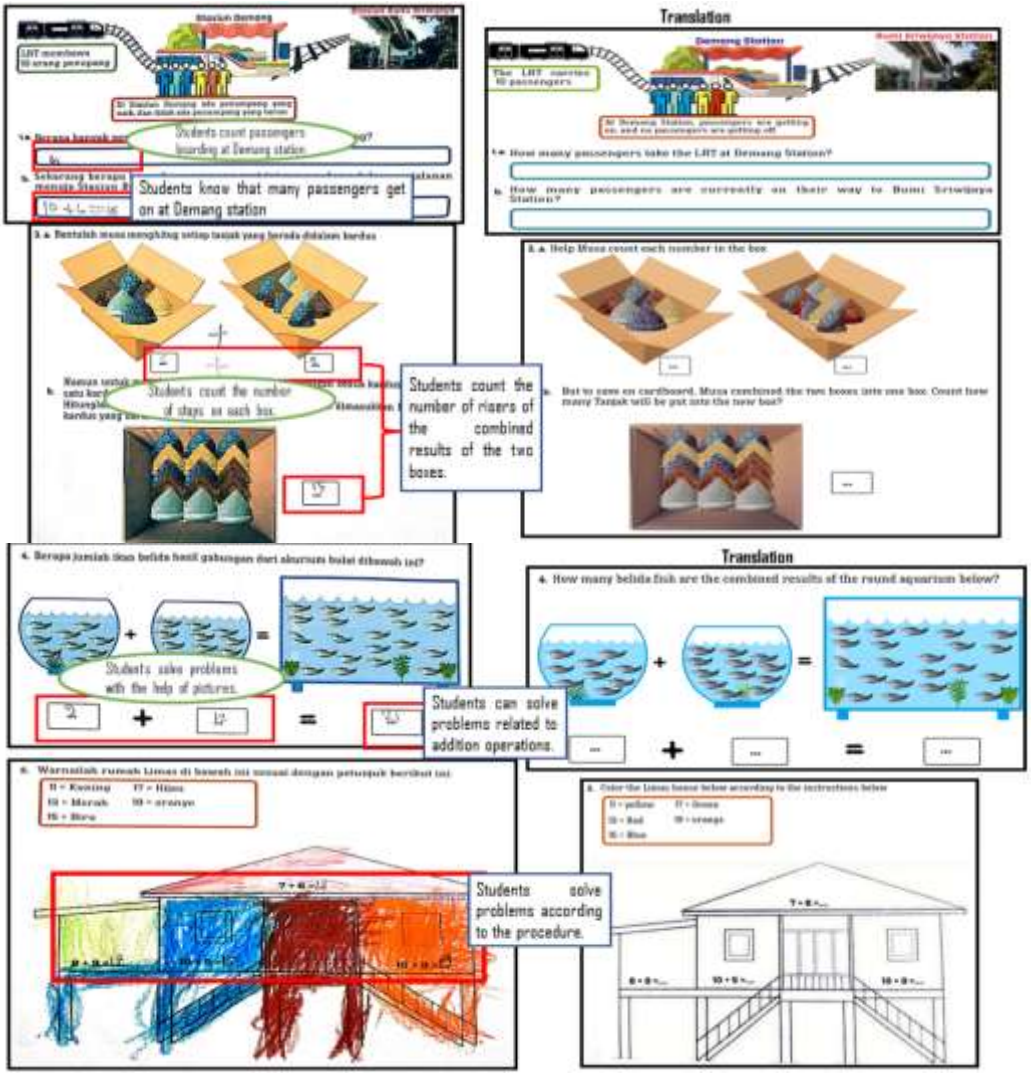
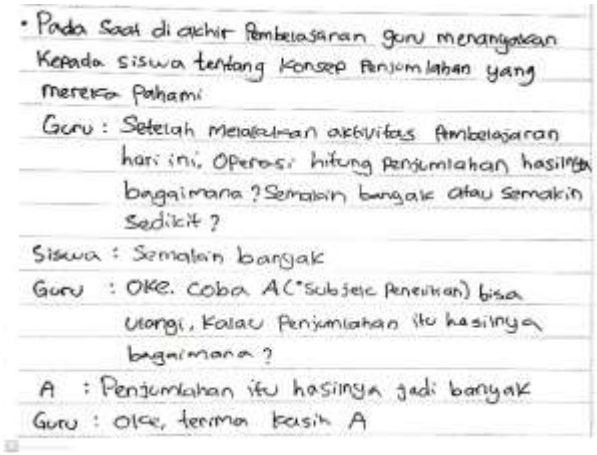


Figure 3. Student's solutions in activity 1 in relation to addition of numbers

Figure 3 shows that the student was able to find out how many passengers got on the LRT at Demang station and how many passengers were on their way to Bumi Sriwijaya station. Furthermore, the student was able to count the number of steps resulting from combining two boxes. Then, the student could solve problems related to addition operations following available procedures. The teacher ensured that the student understood the concept of addition by asking questions to find out whether he could draw a conclusion regarding the concept of addition. The following is the researcher's field notes on the subject.



Translated to English:

At the end of the lesson, the teacher asked students about how they understood the addition concept.
Teacher: after doing today's learning activity, (did you find out) what the results of an arithmetic operation of addition is? (does the number get) bigger or smaller?
Student: Bigger
Teacher: okay, A (*research subject) could you repeat it? What is the result of an addition?
A: the result of an addition is (a) bigger (number).
Teacher: okay, thank you A

Figure 4. The researcher's field notes regarding the addition of numbers

Figure 4 shows that the student could articulate the concept of addition. The subject student was considered capable as he could restate what he had understood about the addition and subtraction materials he had learned by writing down the meaning. As stated Wibowo et al. (2022) and Utomo (2016), it is the ability to restate concepts they have learned in their own language.

Figure 5. Students when demonstrating the condition of passengers on the LRT

In the second meeting, the activity in which students engaged was activity 2. This activity allowed students to understand the concept of subtracting whole numbers. Activity 2 began with students demonstrating in front of the class the condition of passengers getting off the LRT at a station, while no passengers were getting on at that station. Figure 5, provides a picture of student's when demonstrating

the condition of passengers on the LRT in the second meeting. After several times the students demonstrated the condition of passengers getting off the LRT in an orderly manner. The teacher gave students a wide range of activities regarding the subtracting material. From the results of activity two, it is known that students could conclude in their sentences the concept of subtraction. The following is a snippet of student answers in activity 2.

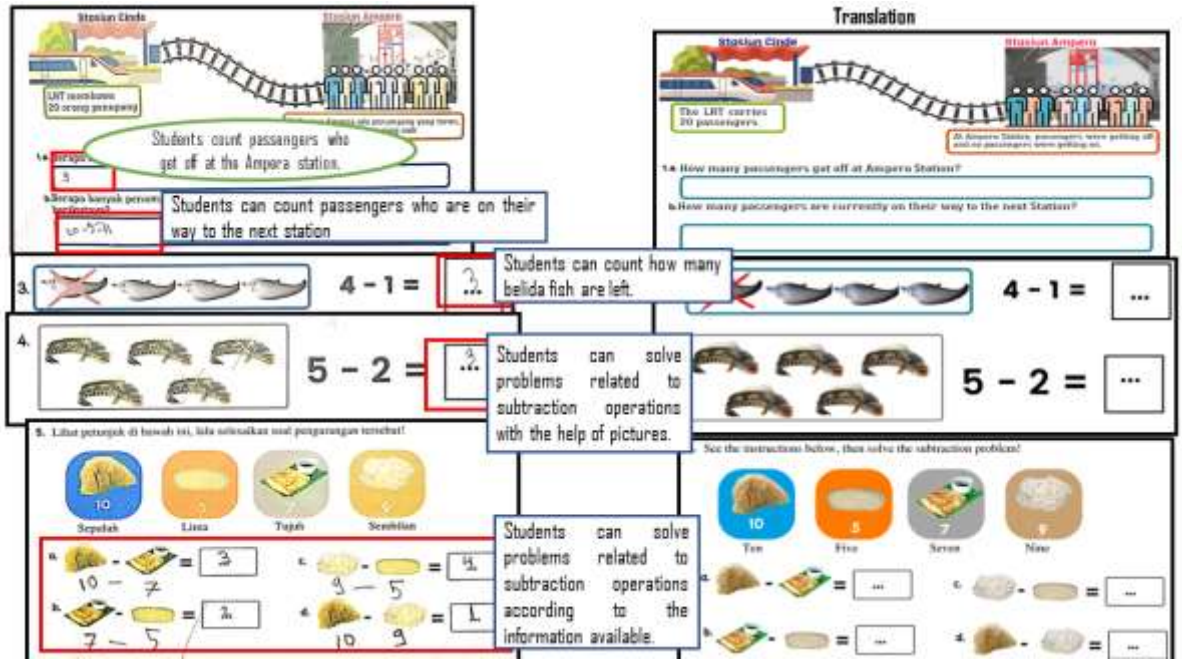
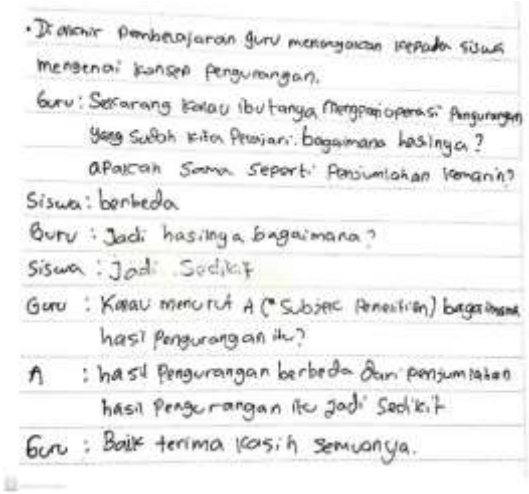


Figure 6. Student's solutions in activity 2 in relation to subtraction of numbers

Figure 6 shows that student could find out how many passengers got off at Ampera station and how many passengers were on their way to the next station. Furthermore, the student could count the remaining belida fish. Then, the student could solve problems related to subtraction operations according to the information available. To ensure that the student understood the concept of subtraction, the teacher asked questions to find out whether the student could deduce the concept of subtraction in his own language. The following is the researcher's field note on the subject.



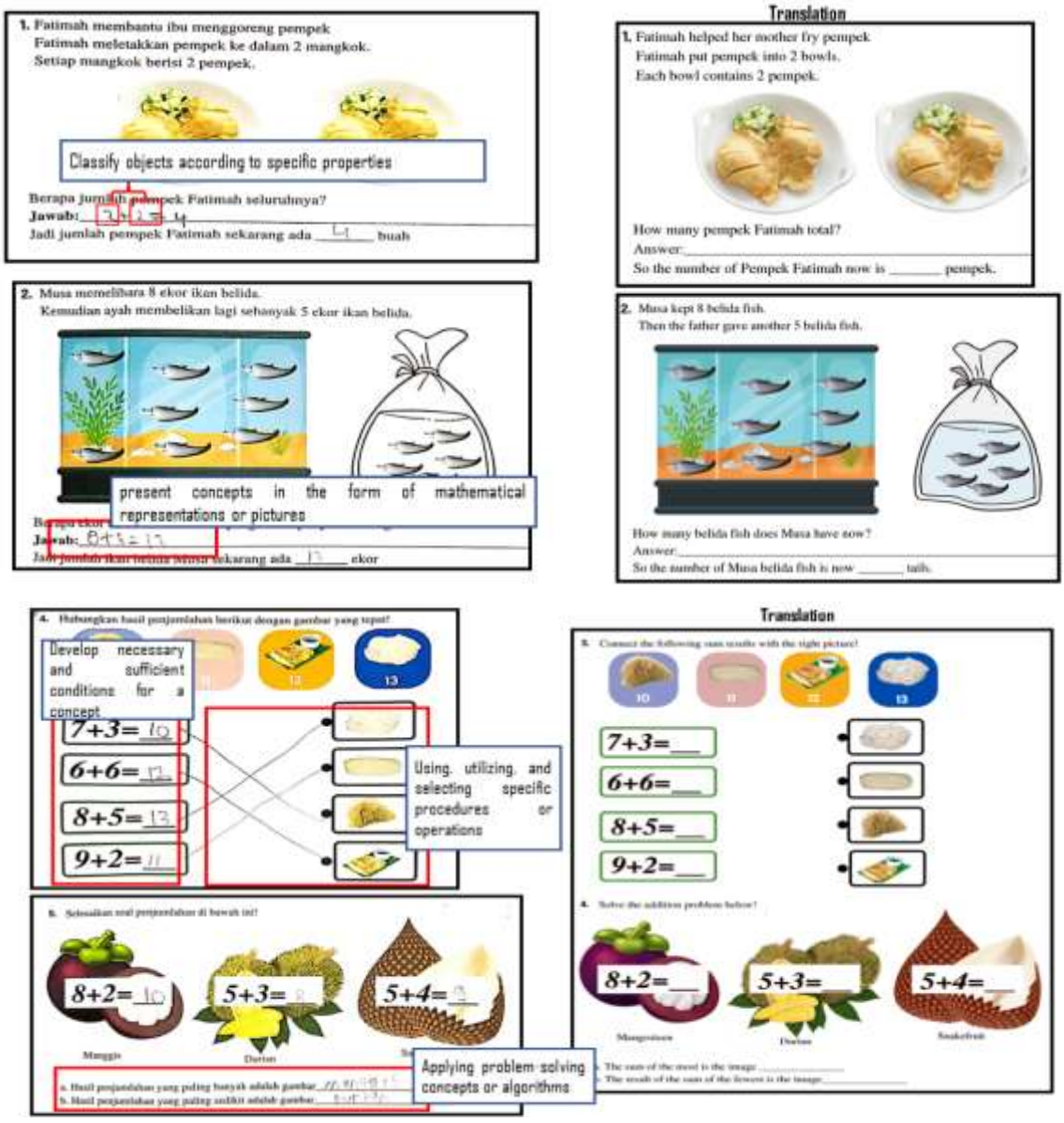
Translated to English:

At the end of the lesson, the teacher asked students about the concept of subtraction.
Teacher: Now, I ask you about subtraction that we have learned what is the result? Is it the same as yesterday?
Student: different
Teacher: So, what is the result?
Student: (it) becomes smaller
Teacher: A (*research subject), in your opinion, what is the result of subtraction?
A: The result of a subtraction is different from the result of an addition; the subtraction result is a smaller number.
Teacher: okay, thank you, everyone

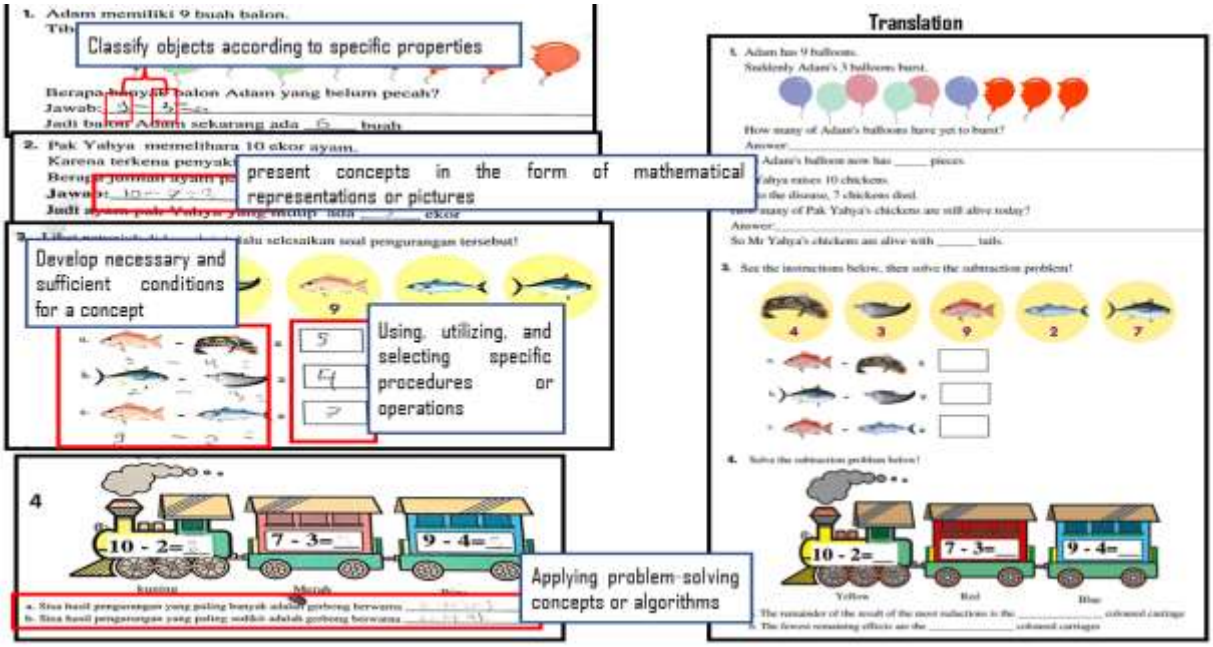
Figure 7. The researcher's field note regarding the subtraction of numbers

From Figure 7 the student was able to articulate the concept of subtraction. The student was considered capable as he could restate what he had understood about the subtraction material that he had learned by writing down its meaning. As stated by Wibowo et al. (2022) and Utomo (2016) it is ability to restate concepts learned in their own language.

Students were given post-test questions in the third meeting, which consisted of four questions on the addition material. Then, at the fourth meeting, students were given post-test questions, which consisted of four questions on the subtraction material. The questions in the post-tests were solved by students individually, which aimed to see how far the students were able to understand the concepts of addition and subtraction to solve problems in everyday life. The following are some student answers to the post-test questions.



(a)



(b)

Figure 8. Student's answers to the post-test questions

Based on Figure 8(a) explains students' answers to post-test questions related to adding numbers while Figure 8(b) relates to subtracting numbers. The students were able to classify objects according to specific characteristics. They could present concepts in the form of mathematical representations or pictures. An indicator that can be seen as a sign that students have a conceptual understanding of a material is that students can group objects based on specific characteristics and convey concepts in the form of mathematical representations (Wibowo et al, 2022; Jusniani, 2018; NCTM, 2000).

Then, the students were also able to develop the necessary and sufficient conditions for a concept. The students could use, utilize, and select specific procedures or operations and apply problem-solving concepts or algorithms. According to Wibowo et al. (2022) and Jusniani (2018), students' conceptual understanding of a material can be seen when they develop necessary and sufficient requirements, then use and utilize specific procedures and apply concepts to solve a problem encountered.

This lesson was designed to produce a learning trajectory for understanding the concepts of adding and subtracting whole numbers for students with ADHD. The description of the learning trajectory using (PMRI) starts with concrete objects. This is also supported by Piaget, who classified cognitive development in the concrete operational phase (7 - 12 years). In this phase, students can understand logical operations with the help of concrete objects.

In line with that, efforts can be made by teachers to maintain the attention of students with ADHD by introduction various topic in a way that attracts their attention and by emphasizing the importance of these topics in students' daily lives (Rokhim, 2017). The activities developed in this study used unique contexts of the city of Palembang, such as the LRT, *belida* fish, traditional houses, and others. Saputri et al. (2022) said that a model can be interpreted as a bridge from real problems to formal mathematics.

Students develop their models, which become the basis for formal mathematics development. The models that occur are models of situations and models for formal mathematics.

This study found that before solving problems related to the addition and subtraction materials, students had first gained knowledge of numbers and the ability to count. This shows that the prerequisite material in learning to understand the concepts of addition and subtraction plays an important role. In mathematics, concepts are interrelated with one another (Amaliya et al., 2022). For instance, concept A is the basic concept of concept B, so concept B cannot be studied before concept A. Rading & Nur (2021) said that the lack of understanding of prerequisite materials on the students' part is one of the causes of the students' making mistakes in solving math problems.

Learning can be commenced orienting students with concrete objects. Activities and questions are designed using contexts familiar to students, in this case unique things related to the city of Palembang. During the learning process, students enthusiastically participated in learning and could understand the problems presented appropriately. This was due to the use of comparative and familiar contexts in the designs of activities and questions. The problems familiar to students will help students, find out that mathematics is a human activity in their immediate surrounding (Lee, et al. 2020).

CONCLUSION

This study produced a learning trajectory for understanding the concepts of addition and subtraction for students with ADHD using unique contexts of the city of Palembang. The learning was designed for conceptual understanding using the PMRI approach. In the learning process, students were able to use their ability to perform addition and subtraction operations to find mathematical solutions to the problems that were designed. Some indicators of conceptual understanding that appeared in the students were the students' abilities to classify objects according to specific characteristics, present concepts in the form of mathematical representations or images, and develop the necessary and sufficient conditions for an idea. Students could use, utilize, and choose specific procedures or operations and apply concepts or problem-solving algorithms. This research can be used as a reference for future research related to the instruction addition and subtraction of whole numbers for children with ADHD using the PMRI approach, using contexts close to students' daily lives involving interesting activities for the children with ADHD.

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