

## Design Learning Trajectory for Understanding the Concept of Fractions in ADHD Students (*Attention Deficit Hyperactivity Disorder*) with Realistic Mathematical Approach

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Article Info	ABSTRACT
<p><b>Keywords:</b> Learning trajectory, design research method, ADHD (Attention Deficit Hyperactivity Disorder) students,</p>	<p>Learning mathematics does not only depend on the material being taught, but also on how the source of the material is provided/delivered and how it is delivered. The low interest in learning mathematics and the difficulty in understanding formulas result in many children being less interested in learning mathematics. The lack of innovative learning media brought by teachers, the use of cellphones for online games makes students rarely open their textbooks. The design of the right learning path can be one of the factors for a teacher's success in carrying out learning activities. The use of the right learning path that has been planned by the teacher is also a factor that can trigger the enthusiasm for reading, thinking and analyzing the material being taught. The design of an effective and efficient learning path functions so that the learning objectives and ability indicators expected of students can be achieved optimally. The ability to understand the concept of addition and subtraction in fraction material is a basic thing that is important for all students, including students with attention and hyperactivity disorders known as Attention Deficit Hyperactivity Disorder (ADHD). This study uses a design research method consisting of three stages: the preparation stage, the two-cycle experimental stage (cycle I: initial experiment, cycle II: teaching experiment), and the retrospective analysis stage. Data collection was carried out through observation, interviews, initial tests, written tests, documentation, and field notes. The application of learning by carrying out real activities and directly witnessing the process of dividing Pizza into several parts makes students understand and be more enthusiastic in solving the questions provided by the researcher. Finally, after a series of research methods carried out, the researcher obtained research results that showed that learning activities designed by creating learning paths and media can actually help students understand the concept of addition and subtraction of fractional numbers. Indicators of conceptual understanding that emerged include the ability to classify objects, present concepts in the form of mathematical representations or images, develop conditions that are necessary and sufficient for a concept, use certain procedures, and apply concepts in problem solving. Finally, a learning path involving two activities with a realistic mathematical learning context supports understanding the concepts of addition and subtraction of fractions.</p>
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### INTRODUCTION

Mathematics is one of the disciplines that plays an important role in developing logical, analytical, and systematic thinking skills. At the elementary school level, mathematics learning aims to build a strong foundation for students in understanding mathematical concepts, one of which is fractions. Understanding fractions is essential because it is a prerequisite for studying advanced materials such as comparisons, percentages, and algebraic operations at the next level of education.

Mathematics is a material that is considered difficult by students in learning mathematics so that students have difficulty in understanding concepts, especially fractions. Some students only see fractions as symbols that need to be manipulated in various ways. The main factor that causes students' difficulty in understanding the concept of fractions is that students memorize more often than building conceptual understanding. Another factor is that the approach used by teachers is not oriented to the real world where the situation can be imagined by students. An alternative approach that can be used as a solution is a realistic mathematics learning approach. According to Permendikbud No. 37 of 2018, one of the basic competencies that

students must master is being able to understand and apply the concept of fractions in everyday life. However, in reality, many students face difficulties in understanding fractions. Therefore, education is very important for one generation to the next (Akrim, 2020; Hidayat, 2024; Simbolon, 2024; Sri 2024). Previous research shows that the concept of fractions is often considered abstract by students, thus requiring an innovative and contextual learning approach to improve students' understanding (Lestari & Kartika, 2020).

Various approaches have been developed to help students understand fractions, including realistic approaches, problem-based learning, and the use of manipulative media. These approaches aim to bridge the gap between students' conceptual and procedural understanding in learning fractions. According to Gravemeijer and Cobb (2006), literature-based learning designs that consider everyday life contexts can help students connect mathematical concepts to their real-life experiences.

Realistic mathematics learning is an approach that can be applied in mathematics. Characteristics of the approach realistic mathematics learning is very broad. One of them is the use of context real situations. Situations that are considered "real" are important in the learning process (Baharuddin et al., 2018). The realistic mathematics learning approach provides students with the opportunity to build their knowledge. Students can also imagine various situations presented in the form of questions because questions about the real world are certainly close to students' lives. Through a realistic approach, students can improve understanding of mathematical concepts (Fitriani et al., 2016; Wahidin et al., 2014)

The use of real-world problems will help students improve their understanding abstract concepts (Zakaria et al., 2017). Because it uses real-world problems, Of course, the problems presented in the realistic mathematics learning approach will use the context of everyday life. The problems presented also raise mathematization process. The material makes students think in various activities, used as motivation and to show how mathematical concepts are applied in the context of questions (Vos, 2018).

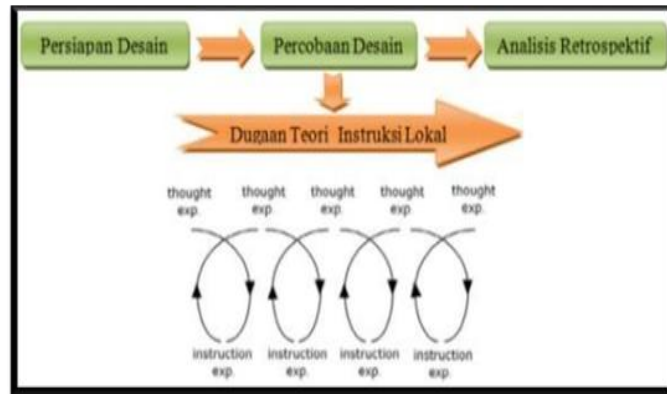
On the other hand, literature on fractional learning reveals that learning success is not only determined by teaching strategies, but also by the systematic design of learning trajectories. A good learning trajectory allows students to gradually build conceptual understanding, from concrete to abstract stages (Van de Walle et al., 2016). Therefore, this study aims to design a learning literature design that can improve elementary school students' understanding of fractions.

Referring to various previous studies, this study focuses on the development of learning literature design for understanding the concept of fractions involving contextual activities, manipulative media, and problem-based approaches. It is hoped that this design can be a practical and effective solution for teachers in overcoming the challenges of learning fractions in elementary schools.

## **RESEARCH METHOD**

This study uses a design research method (design research) with a validation study type. Design Research is a research method that focuses on the development and validation of certain designs, products, or innovations that are carried out through an iterative cycle of planning, implementation, evaluation, and revision. This method

is usually used in the context of education, technology, and social sciences to create evidence-based solutions to real problems.



**Figure 1.** Design Research Cycle (Gravemijer, 2004)

Main Characteristics of Design Research:

1. Real Problem Based:
  - It starts with identifying a real-world problem that requires an innovative solution.
2. Iterative and Repeating Cycles:
  - The process involves an iterative cycle of design, implementation, evaluation, and revision.
3. Collaborative:
  - Involving various parties, including practitioners (e.g., teachers) and researchers, to ensure the relevance and application of research results.
4. Generating Theory and Products:
  - In addition to producing tested products or designs, this research also contributes to the theory related to the design.

The research was conducted in three stages:

1. Preparation Stage:
  - Literature review and design of Hypothetical Learning Trajectory (HLT).
  - HLT is designed for ADHD students with real-world learning contexts.
2. Experimental Design Stage:
  - Cycle 1: Initial experiment to test HLT.
  - Cycle 2: Teaching experiments with real subjects in inclusive classes.
3. Retrospective Analysis:
  - Data from the teaching experiment were compared with the designed HLT.

Data collection was carried out through observation, interviews, initial tests, written tests, documentation, and field notes.

**RESULTS AND DISCUSSION**

This research was conducted at SDIT Tahfizul Qur'an by first preparing the learning path, teaching materials, and things needed in data collection. In the results of the interview with the class teacher, he stated that by giving real examples to students in delivering fractional material and cutting objects / pizza directly, they understand more and increase their motivation and interest in learning mathematics.

Activity	Objective Learning	Activity Description	Student Thinking Conjecture
Cut Pizza	Students can find out meaning of fraction	The teacher encourages students to mention the value of fractions.	Students cut pizza randomly according to teacher's instructions Students mention the value of pizza slices in units
Drawing a Pizza Slice	Students can mention the value of certain fractions	Students work in groups to draw a circle-shaped pizza cut into pieces. Students color one of the pizza slices or a slice of circle	Students draw circles randomly so that the areas of the segments are not the same. Students draw proportional pieces of a circle
Fractional Sector	Students can mention equivalent fractions.	Students work in groups to compare two identical fractions across several equal fractional segments.	Students try to place the segments on the main circle (where the fractional segments are) so that the correct fractional value is obtained. Students compare several segments that show the same fractional value.
Fractional plot	Students can add two fractions.	In group activities, students color the fraction squares that show certain	Students can color the squares correctly when adding fractions with the same denominator.

		fractions.	
		The teacher encourages students by showing that the combination of the colored squares shows the result of adding two numbers. fraction of equal value	Students experience a dead end in combining colored squares in the addition of fractions with unlike denominators.
Adding upn and subtractin g two fractions	Students can add and subtract two fractions with the same denominat or	The teacher encourages students to find equivalent fractions so that the denominators of the two fractions can be added or subtracted.	Students get equivalent fractions from two fractions but the two fractions cannot be added or subtracted.  Students get equivalent fractions by multiplying the numerators and denominators respectively.

The learning trajectory design that we have prepared and presented in class with our supervising lecturer is as follows:

1. Topic: Fractions for Grade V Elementary School
2. Basic Competence: Understanding and Determining the Results of Arithmetic Operations on Various Forms of Fractions.

**Learning Objectives:**

- A. Through a Realistic Mathematics Learning Approach, students are able to understand various forms of fractions correctly.
- B. Through the Realistic Mathematics Learning approach, students are able to determine the results of addition operations of various forms of fractions correctly.
- C. Through the Realistic Mathematics Learning approach, students are able to determine the results of subtraction operations of various forms of fractions correctly.

**Basic Understanding of Fractions:**

**Objective:** Through the Realistic Mathematics Learning approach, students are able to understand various forms of fractions (ordinary fractions, mixed fractions, and decimal fractions) correctly.

Learning Flow:

- Identify fractional parts using concrete objects (e.g., a cut cake, a ribbon, or part of a circle).
- Comparing simple fractions using visual illustrations (e.g., bar graphs or pie charts).
- Classify the forms of fractions (ordinary fractions, mixed fractions, and decimals).

**Fraction Addition Operation:**

**Objective:** Through the Realistic Mathematics Learning approach, students are able to determine the results of addition operations of various forms of fractions correctly.

Learning Flow:

- Recognize the denominators of fractions and equate denominators.
- Adding fractions that have the same denominator using real examples (e.g., cutting pizza, ribbon, watermelon into certain sizes).
- Adding fractions with unlike denominators through visualization (e.g., using pictures of pizza slices or manipulatives).
- Solve contextual problems involving the addition of fractions (e.g., calculating the total portions of a pizza).

**Fraction Subtraction Operation:**

**Objective:** Through the Realistic Mathematics Learning approach, students are able to determine the results of subtraction operations of various forms of fractions correctly.

Learning Flow:

- Simplify fractions before subtracting.
- Using concrete visualizations (such as a picture of a pizza divided into several pieces/fractions) to understand subtraction of fractions.
- Solve contextual problems involving fraction subtraction (e.g., calculating the remainder of a divided pizza).

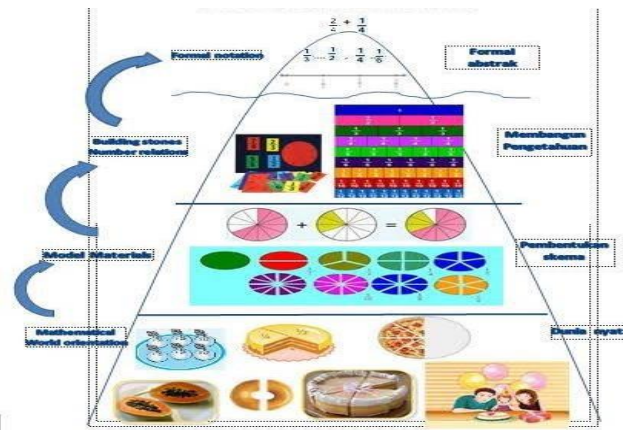




Figure 2: Iceberg Structure Diagram in Preparing Students' Learning Paths

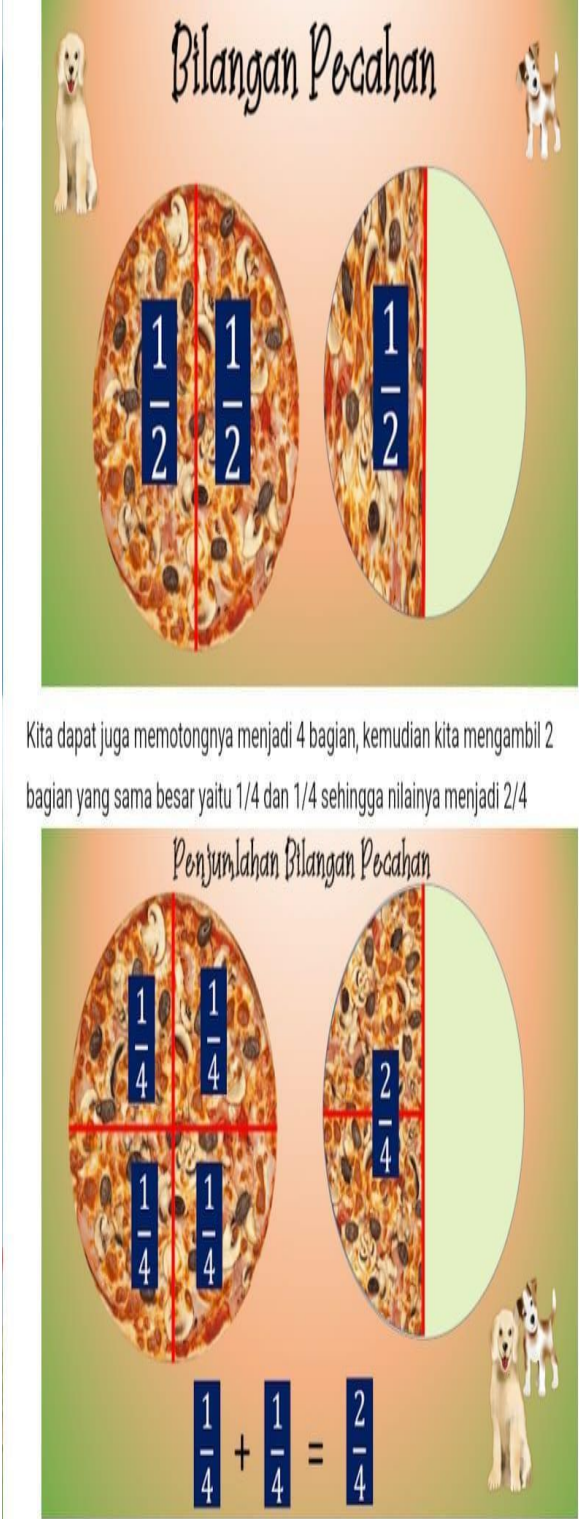
<p>1</p>	<p>Introduction to early understanding of fractions through everyday activities (cutting pizza, dividing oranges and snake fruit).</p>	<p>Understanding the Basic Concept of Fractions.</p>	<p>Provides questions to recall understanding related to everyday life in fraction material.</p> <p>2. Provide real materials such as pizza, oranges, apples, pears to be cut as a real activity to understand the concept of fractions.</p> <p>3. Provide activities using visualization (pictures, animated videos) Provide puzzles</p>	<p>1. Students pay attention and stimulate their thinking in everyday life such as real materials, namely pizza, oranges, apples, pears, which they cut into pieces or divided into 4 parts directly guided by their teacher, so each part is only 1/4.</p> <div data-bbox="746 524 1286 763"> </div> <div data-bbox="759 804 1295 1095"> </div> <p>2. Students watch from internet media via the YouTube page: <a href="https://www.youtube.com/watch?v=JLECRclUg9s">https://www.youtube.com/watch?v=JLECRclUg9s</a></p> <p>3. Students cut out parts of the puzzle picture to assemble carefully.</p> <div data-bbox="767 1426 1383 1697"> </div> <div data-bbox="767 1713 1362 1973"> </div>
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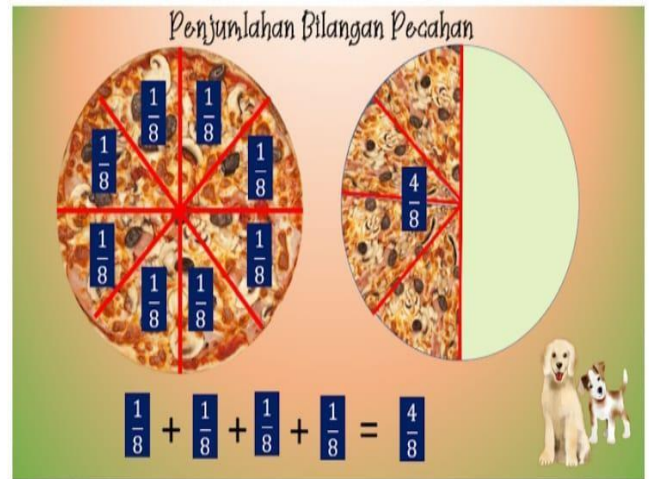
			that are divided into several parts to be assembled into a whole.	
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<p>2</p>	<p>Development</p>	<p>Deepening the understanding of fraction on concepts contextually with a realistic mathematical approach.</p>	<p>1. Using real examples (cutting, dividing pizza) to deepen understanding of fractions.</p> <p>2. Develop the ability to compare and order fractions using visual media and directly demonstrate the comparison of equivalents and the order of fractions.</p> <p>With the provision of visual images</p>	<p>1. Students cut the pizza into <math>\frac{1}{2}</math> parts. Then from the <math>\frac{1}{2}</math> part it is cut into two parts, and so on so that a fraction of <math>\frac{1}{2} = \frac{2}{4} = \frac{4}{8}</math> is formed.</p>  <p>2. Students can also observe directly to understand the concept of value assessment via the YouTube page:</p> <p><a href="https://www.youtube.com/watch?v=z-INNB2neCo&amp;t=1s">https://www.youtube.com/watch?v=z-INNB2neCo&amp;t=1s</a></p> <p>Sekarang kita dapat melihat ada berbagai cara untuk membuat pizza itu memiliki ukuran yang sama yaitu <math>\frac{1}{2}</math>.</p>  <p>Kita dapat melihat potongan pizza yang memiliki nilai <math>\frac{1}{2}</math>, <math>\frac{1}{4}</math>, <math>\frac{4}{8}</math>, <math>\frac{8}{16}</math> memiliki ukuran yang sama. Bilangan-bilangan itu dikatakan bilangan pecahan yang senilai.</p> <p>Kita tidak harus menggambar terlebih dahulu atau bahkan mempraktikkannya untuk mengetahui apakah dua buah bilangan pecahan senilai atau tidak senilai.</p> <p>Perhatikan gambar berikut!</p>  <p>Pembilang maupun penyebut dikalikan dengan bilangan yang</p>
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			<p>from the teacher, students carry out a live demonstration of cutting a pizza which shows the process of adding fractions.</p>	
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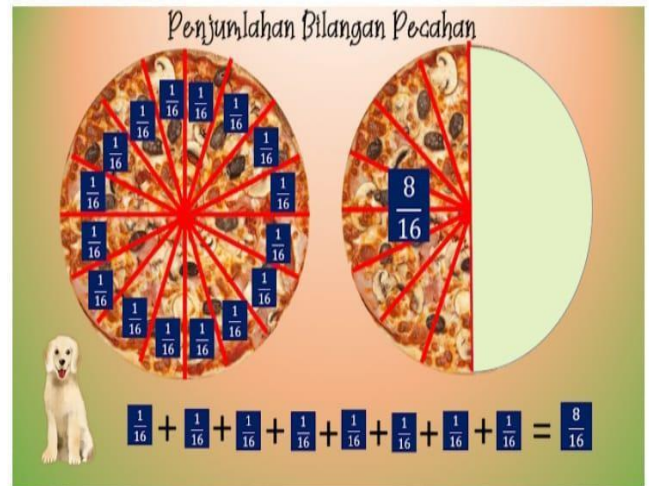
3	<p>Problem solving Fractional forms in the addition process that have the same denominator.</p>	<p>Building a Real Concept of Pizza Division in the Process of Adding Fractions Correctly.</p>	<p>The visualization media is a pizza cutting activity as shown in the picture:</p>  <p>Kita dapat juga memotongnya menjadi 4 bagian, kemudian kita mengambil 2 bagian yang sama besar yaitu <math>\frac{1}{4}</math> dan <math>\frac{1}{4}</math> sehingga nilainya menjadi <math>\frac{2}{4}</math></p> <p>Selain itu, kita dapat membaginya menjadi 8 bagian yang sama besar, kemudian kita mengambilnya 4 bagian yang sama besar. Sehingga <math>\frac{1}{8} + \frac{1}{8} + \frac{1}{8} + \frac{1}{8}</math> menjadi <math>\frac{4}{8}</math> bagian.</p>
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Penjumlahan Bilangan Pecahan


$$\frac{1}{8} + \frac{1}{8} + \frac{1}{8} + \frac{1}{8} = \frac{4}{8}$$

Bahkan kita dapat memotongnya menjadi 16 bagian yang sama besar, kemudian kita mengambil 8 bagian sehingga nilainya menjadi  $\frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16}$  atau 8 kali  $\frac{1}{16}$  sehingga nilainya menjadi  $\frac{8}{16}$ .

Penjumlahan Bilangan Pecahan


$$\frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} = \frac{8}{16}$$

Sekarang kita dapat melihat ada berbagai cara untuk membuat pizza itu memiliki ukuran yang sama yaitu  $\frac{1}{2}$ .

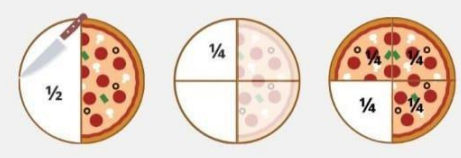


**Contoh  $\frac{1}{2} + \frac{1}{4}$**




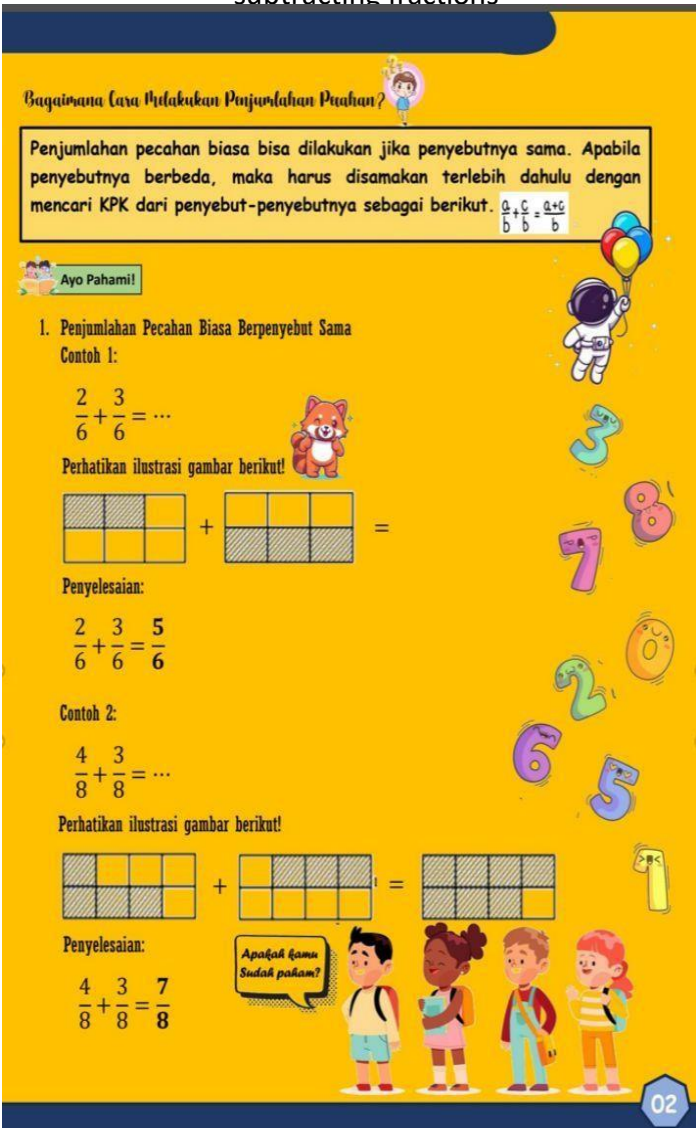
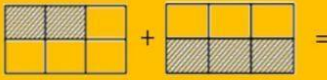
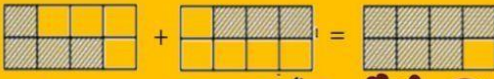
Dari gambar diatas diketahui bahwa potongan bagian  $\frac{1}{2}$  pizza tidak bisa langsung ditambahkan pada potongan  $\frac{1}{4}$  pizza, begitu pun sebaliknya. Karena  $\frac{1}{2}$  potongan pizza lebih besar dari  $\frac{1}{4}$  potongan pizza. Sehingga salah satu potongan harus menyesuaikan dengan potongan pizza lainnya.

#AsyikBermatematika



				<div data-bbox="821 224 1404 313" style="background-color: #8B4513; color: white; padding: 5px; text-align: center;"> <h2 style="margin: 0;">Katakan pada Anak</h2> </div> <div data-bbox="877 336 1340 492" style="text-align: center;">  </div> <div data-bbox="829 515 1404 795"> <ul style="list-style-type: none"> <li>"Bayangkan kamu punya 2 bentuk potongan pizza, potongan besar dan potongan kecil."</li> <li>"Kalau kamu mau tahu total pizza yang kamu makan, kamu harus membuat semua potongan jadi ukuran yang sama dulu. Jadi, 1/2 potongan pizza diiris lagi dan berubah menjadi 2/4, supaya potongannya sama besar dengan potongan pizza 1/4."</li> <li>"Kalau sudah sama besar, kamu tinggal tambahkan jumlah potongannya: <math>2/4 + 1/4 = 3/4</math>."</li> </ul> </div> <div data-bbox="813 828 1053 873" style="text-align: center;"> <p>#AsyikBermatematika</p> </div> <div data-bbox="1356 795 1452 896" style="text-align: right;">  </div>
<p>4</p>	<p>Problem solving Form fractions in the process of reducing the same denominator.</p>	<p>Building a Real Concept of Pizz a Division in the Process of Subtracting Fractions Correctly.</p>	<p>With the provision of visu al images from the teacher, students carry out a live demonstr ation of cutting a pizza which shows th e process of adding fractions.</p>	<p>1. The teacher asked the students to cut the pizza directly according to the pizza cutting media that had been presented visually on the YouTube page and then solve problems related to the addition operation.</p> <div data-bbox="782 1209 1380 1534" style="text-align: center;">  </div> <p>2. Students try to solve the problem of subtracting fractions correctly for those with the same denominator by demonstrating pizza slices through visual media from YouTube:</p> <p style="text-align: center;"> <a href="https://youtu.be/ud14WwUC_0?si=65zoazfv0TVXNOug">https://youtu.be/ud14WwUC_0?si=65zoazfv0TVXNOug</a> </p>



				
<p>5</p>	<p>Providing reinforcement of material by teachers for understanding the concept of fractions, addition and subtraction of fractions with the same denominator.</p>	<p>The teacher provides reflection on learning.</p>	<p>The teacher distributes teaching materials containing a summary of the lesson on material that has been studied today.</p>	<p>Summary material for lessons on adding and subtracting fractions</p>  <p>Summary material for lessons on adding and subtracting fractions</p> <p>Bagaimana cara Melakukan Penjumlahan Pecahan?</p> <p>Penjumlahan pecahan biasa bisa dilakukan jika penyebutnya sama. Apabila penyebutnya berbeda, maka harus disamakan terlebih dahulu dengan mencari KPK dari penyebut-penyebutnya sebagai berikut. <math>\frac{a}{b} + \frac{c}{b} = \frac{a+c}{b}</math></p> <p>Ayo Pahami!</p> <p>1. Penjumlahan Pecahan Biasa Berpenyebut Sama</p> <p>Contoh 1:</p> $\frac{2}{6} + \frac{3}{6} = \dots$ <p>Perhatikan ilustrasi gambar berikut!</p>  <p>Penyelesaian:</p> $\frac{2}{6} + \frac{3}{6} = \frac{5}{6}$ <p>Contoh 2:</p> $\frac{4}{8} + \frac{3}{8} = \dots$ <p>Perhatikan ilustrasi gambar berikut!</p>  <p>Penyelesaian:</p> $\frac{4}{8} + \frac{3}{8} = \frac{7}{8}$ <p>Apakah kamu Sudah paham?</p>

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The documentation for students in carrying out realistic mathematics learning is as follows:



The following are the details of the learning trajectory design that has been carried out:



1. Main:
  - Learning using real context of pizza slices
  - Help ADHD students understand the concept of adding and subtracting fractions.
  - Indicators of conceptual understanding include the ability to classify objects, present concepts in mathematical representations, and apply problem-solving algorithms.
2. Implementation of Activities:
  - Activity 1 (Addition): Students demonstrate directly how to cut a pizza guided by the teacher so that they are able to really understand the arithmetic operation of adding fractions.
  - Activity 2 (Subtraction): Students are able to demonstrate the arithmetic operation of subtracting fractions in a real context.
  - Each activity is designed to utilize a context familiar to students.
3. Post-Test Results:
  - Students can solve addition and subtraction problems of fractions with the same denominator using the correct procedure.
  - Students demonstrate conceptual understanding through correct answers and visual representations.
4. Conclusion:
  - The designed learning trajectory is effective in increasing conceptual understanding of ADHD students.
  - This study provides a reference for the development of mathematics learning for students with special needs.

## **CONCLUSION**

The concept of fractions is often considered as one of the most challenging materials, both to teach and to be understood by students. This is due to the tendency of most students to only see fractions as a series of symbols, without understanding their meaning in depth. To overcome this obstacle, teachers need to provide a deep and fundamental understanding of the concept of fractions, especially by building the right learning trajectory and linking it to real experiences that are relevant to students' lives. One approach that has proven effective is the realistic mathematics learning method. Based on research, this approach is able to improve students' ability to understand the concept of fractions. By connecting fraction material to real-world contexts, students find it easier to understand abstract concepts and link them to their own experiences. Therefore, an approach based on real- world situations can be a solution to help students strengthen their understanding of the concept of fractions gradually and meaningfully.

The Realistic Mathematic Education (RME) approach can improve the understanding of fraction concepts in grade 5 students of SDIT Swasta Tahfizul Quran, including students with ADHD. Specially designed learning path activities help students understand the material in a more relevant and contextual way, thereby increasing their engagement and learning outcomes and stimulating their curiosity in the learning process. The importance of the flow of the learning path arrangement motivates teachers to be able to innovate in preparing a conducive and efficient learning atmosphere to advance education in Indonesia.

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