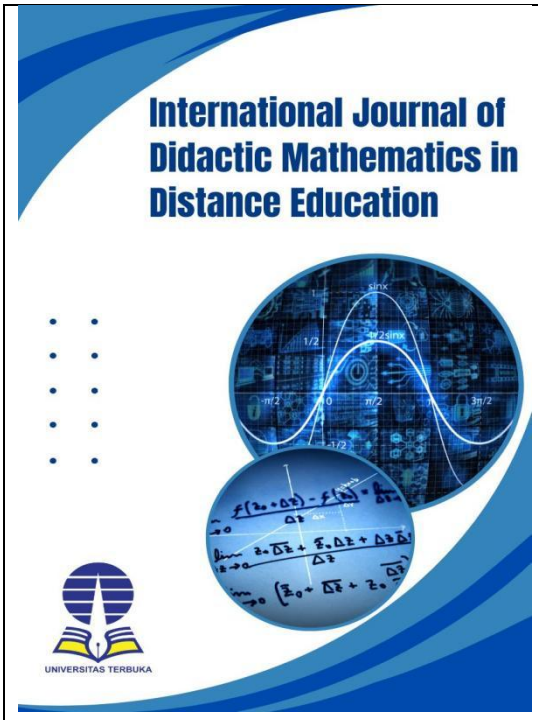
International Journal of Didactic Mathematics in Distance Education

Journal homepage: https://jurnal.ut.ac.id/index.php/ijdmde



From confusion to fun: Box Fraction Media for better understanding of fractions

Karin Hernelia Putri[1], Farhatul Azizah[2], Nabilah Putri Kamelia[3], Jepri Stiven[4], Elsa Susanti[5*], Zulkardi[6], Budi Mulyono[7], Meryansumayeka[8]

[1]Universitas Sriwijaya, Palembang, Indonesia, kyrnputri@gmail.com
[2]Universitas Sriwijaya, Palembang, Indonesia, farhatulazizah005@gmail.com
[3]Universitas Sriwijaya, Palembang, Indonesia, bilaacious@gmail.com
[4]Universitas Sriwijaya, Palembang, Indonesia, jepristiven19@gmail.com
[5*]Universitas Sriwijaya, Palembang, Indonesia, elsasusanti@fkip.unsri.ac.id
[6]Universitas Sriwijaya, Palembang, Indonesia, zulkardi@unsri.ac.id
[7]Universitas Sriwijaya, Palembang, Indonesia, budi_mulyono@fkip.unsri.ac.id
[8]Universitas Sriwijaya, Palembang, Indonesia, meryansumayeka@fkip.unsri.ac.id

To cite this article:
Putri, K.H., Azizah, F., Kamelia, N.P., Stiven, J., Susanti, E., Zulkardi, Z., Mulyono, B., & Meryansumayeka, M (2025). From confusion to fun: Box Fraction Media for better understanding of fractions. *International Journal of Didactic Mathematics in Distance Education*, *2*(2), 189-206.
To link to this article:
https://jurnal.ut.ac.id/index.php/ijdmde
Published by:
Universitas Terbuka
Jl. Pd. Cabe Raya, Pd. Cabe Udik, Kec. Pamulang, Kota Tangerang Selatan, Banten 15437

International Journal of Didactic Mathematics in Distance Education
Volume 2, Issue 2, pp. 189 – 206, E-ISSN: 3047-9207
https://jurnal.ut.ac.id/index.php/ijdmde

From confusion to fun: Box Fraction Media for better understanding of fractions

Karin Hernelia Putri[1], Farhatul Azizah[2], Nabila Putri Kamelia[3], Jepri Stiven[4], Elsa Susanti[5*], Zulkardi[6], Budi Mulyono[7], Meryansumayeka[8]
[1]Department of Mathematics Education, Universitas Sriwijaya, Palembang, Indonesia, kyrnputri@gmail.com
[2]Department of Mathematics Education, Universitas Sriwijaya, Palembang, Indonesia, farhatulazizah005@gmail.com
[3]Department of Mathematics Education, Universitas Sriwijaya, Palembang, Indonesia, bilaacious@gmail.com
[4]Department of Mathematics Education, Universitas Sriwijaya, Palembang, Indonesia, jepristiven19@gmail.com
[5]Department of Mathematics Education, Universitas Sriwijaya, Palembang, Indonesia, elsasusanti@fkip.unsri.ac.id
[6]Department of Mathematics Education, Universitas Sriwijaya, Palembang, Indonesia, zulkardi@unsri.ac.id
[7]Department of Mathematics Education, Universitas Sriwijaya, Palembang, Indonesia, budi_mulyono@fkip.unsri.ac.id
[8]Department of Mathematics Education, Universitas Sriwijaya, Palembang, Indonesia, meryansumayeka@fkip.unsri.ac.id

*Correspondence: elsasusanti@fkip.unsri.ac.id

Abstract
Students' low understanding of fractions is a major obstacle to achieving basic mathematical competence at the primary school level. To address this issue, innovative, engaging, and easy-to-understand learning media are required to help students grasp fraction concepts more effectively. This study aims to design and evaluate a participatory and interactive game-based learning medium called Box Fraction Fun. The Research and Development (R&D) method was employed, using the ADDIE model. Validation by two subject matter experts and two media experts showed that the medium was considered suitable to highly suitable based on a four-level suitability scale. Practicality was assessed through questionnaires given to three fourth-grade students and one teacher at a public elementary school in Bukit Lama district, Palembang, with results indicating that the medium was "very practical." The effectiveness of the medium was evaluated using pre-test and post-test scores analyzed with N-gain calculations, which demonstrated significant improvement in students' understanding of fractions. These findings suggest that Box Fraction Fun is highly valid, practical to use, and effective in supporting students' learning. Theoretically, this study contributes to the literature on the development of interactive game-based mathematics learning media. Practically, it provides teachers with an innovative and effective tool to enhance students' understanding of fractions.

Article History
Received:
03 June 2025
Revised:
19 August 2025
Accepted:
30 August 2025
Published Online:
03 October 2025

Keywords:
ADDIE;
Interactive;
Fraction;
Mathematics learning;
Media development

1. Introduction

Mathematics is one of the subjects that greatly requires an innovative learning approach. In addition to requiring conceptual understanding, mathematics also demands logical and creative thinking skills. In everyday life, the application of mathematical concepts such as fractions often occurs unconsciously, for example when dividing a cake or pizza. Unfortunately, many students still perceive mathematics as a difficult and boring subject (Kholil & Zulfiani, 2020), particularly because the learning process is still dominated by lecture-based methods that do not actively engage students (Mashuri, 2019). This directly impacts students' low interest and academic performance.

Based on observations and initial interviews at one elementary school in Palembang, it was found that most teachers still use conventional teaching methods such as lectures and textbooks. Teachers said that this approach has been used for a long time and has not been accompanied by the use of visual or interactive learning media. During the learning process that was observed, the teacher explained the material on fractions verbally without concrete aids, while the students only played the role of passive listeners. This makes students passive listeners without the opportunity to explore the concept of fractions visually and manipulatively (Nadirah et al., 2024). As a result, many students, especially those with low abilities, struggle to represent fractions in the form of images. This condition becomes an obstacle in achieving optimal learning outcomes.

One of the main obstacles in mathematics learning, especially fractions, is the lack of interactive and contextual learning media. The limitations in the use of media cause students to struggle in fully understanding concepts (Sari et al., 2024). However, educational media serve as tools for teachers to present material in a concrete, engaging, and easily understandable manner. Well-designed media can support the development of students' cognitive abilities and character (Saleh et al., 2023), as well as enhance their understanding and motivation to learn, especially when presented in the form of interactive multimedia or educational games (Marleni et al., 2021).

Various studies show that game-based learning strategies can develop students' critical and analytical thinking skills in mathematics (Anggoro et al., 2024). Zhang et al. (2020), through a quasi-experimental study in China, found that the use of game-based digital applications in fraction material deepened conceptual understanding and supported knowledge transfer to new contexts. Similar support is provided by Lampropoulos et al. (2022), Beşaltı & Kul (2021) and Bhatia et al. (2022), who each reported that the use of game-based media not only improves students' learning outcomes and self-confidence but also promotes mastery of decimal concepts and numeracy.

On the other hand, the use of innovative learning media at the elementary school level is still not optimal. This is due to teachers' limited knowledge of media, lack of training, and cost constraints (Ulfah et al., 2021). However, teachers can actually develop learning media from simple materials around them (Hastutik, 2021). Simple yet contextual media have proven to be effective in helping students understand mathematical concepts concretely (Azzahra et al., 2024). For example, Salsabila et al. (2022) showed that locally contextualized multimedia increased student engagement and understanding more than generic teaching materials. Similar support also comes from Malaluan & Andrade (2023), who proved that contextual video aids embedded with questions can significantly increase students' interest and critical thinking.

Based on observations and initial interviews at one elementary school in Palembang, it was found that most teachers still use conventional teaching methods such as lectures and textbooks. Teachers said that this approach has been used for a long time and has not been accompanied by the use of visual or interactive learning media. During the learning process that was observed, the teacher explained the material on fractions verbally without concrete aids, while the students only played the role of passive listeners. This makes students passive listeners without the opportunity to explore the concept of fractions visually and manipulatively (Nadirah et al., 2024). As a result, many students, especially those with low abilities, struggle to represent fractions in the form of images. This condition becomes an obstacle in achieving optimal learning outcomes.

This gap highlights the importance of developing innovative learning media that is practical and relevant to students' lives. The findings of Ulfah et al., (2021) show that game media such as Uno cards can increase student interaction and understanding of the material. This is in line with Hriadi et al., (2024), who state that engaging learning media encourages enjoyable learning experiences and improves academic performance.

This study aims to design and develop Box Fraction Fun learning media that can be used in teaching fractions to fourth-grade elementary school students. This media is expected to be a practical, fun, and interactive solution that helps students better understand the concept of fractions and apply it in their daily lives. The main contribution of this study lies in providing alternative learning media that can be accessed and utilized by teachers to improve the quality of mathematics learning in elementary schools. Common

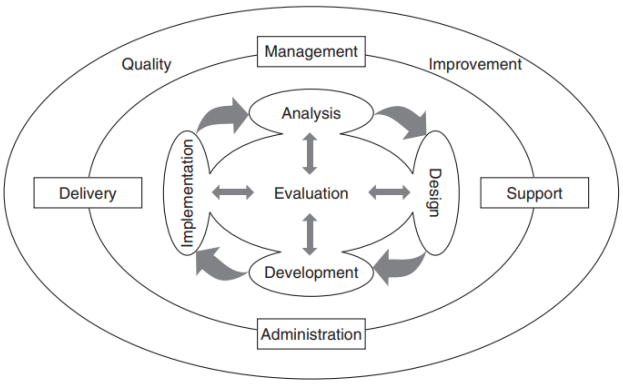
issues in elementary education in Indonesia still revolve around low student engagement in learning and limited use of learning media that support conceptual learning. As a result, many students have difficulty understanding abstract material such as fractions, because learning is still textual and lacks context. Therefore, the development of engaging and relevant game-based learning media is an important effort in addressing the challenges of mathematics learning in elementary schools today.

2. Method

2.1. Research Design

This research is applied with Research and Development (R&D) method that refers to ADDIE model (Analyze, Design, Development, Implement, Evaluate). The ADDIE model was chosen because of its systematic, simple, and flexible structure, which allows for the development of learning media to be carried out in a gradual and controlled manner. Compared to other R&D models, ADDIE is easier to apply to practical educational products, such as learning media. In addition, this model also allows for continuous evaluation at each stage, so that the final results are more optimal and in line with user needs. In general, there are 5 steps of ADDIE as shown in Figure 1.

ADDIE model scheme



Source: (Allen, 2006)

The ADDIE model consists of five main stages that are interrelated. The first stage, Analysis, includes assessing needs and identifying students' difficulties in learning fractions. Next, in the Design stage, researchers design media development based on the results of the analysis, including determining concepts, designs, tools, and materials for Box Fraction Fun. The Development stage aims to produce media and select the best form of the design results. At this stage, researchers begin to create the media and make initial revisions. Following this, the Implementation stage is carried out by testing the media with elementary school students to assess its effectiveness and practicality. Finally, the Evaluation stage is conducted to assess the results of the implementation. Based on this evaluation, the media is revised to make it more effective and ready for optimal use.

2.2. Research subjects

The subjects in this study consisted of three fourth grade students and one mathematics teacher from one of the elementary schools in bukit lama, palembang city. The selection of students was done purposively by considering variations in academic ability (high, medium, and low) based on the results of previous math scores and recommendations from the class Teacher. This approach is in line with the view of Etikan et al (2016), which states that purposive sampling is an appropriate method when researchers seek to explore in-depth information from individuals who have special characteristics. The teachers involved are teachers who Actively teach mathematics in grade iv and have a minimum of five years of experience in Learning mathematics in elementary schools. In this study, the teacher acts as a subject who Provides an assessment of the learning media based on his observations during the process of Using the media by students, as well as providing input related to the practicality of the media From the point of view of field practitioners. Teachers do not play a direct role in the process of implementing learning interventions.

Meanwhile, to assess the validity and practicality of The product, an instrument in the form of an assessment sheet was used by two experts, Namely media experts and material experts, who are lecturers of the mathematics education Study program at sriwijaya university. According to Zhou et al (2023) in the stem metaanalysis, expert involvement is very important to ensure the quality of learning products and the Validity of instruments before further testing. Meanwhile, the effectiveness of the learning Media was tested through giving pre-test and post-test to the three students involved, to see the Improvement of learning outcomes after the use of the media. Farra et al (2024)revealed that elementary school students showed a more significant increase in learning outcomes when using concrete props compared to digital-based props in fraction learning.

2.3. Data Collection

In this section, the data collection methods used in the study are described in detail. The data in this study were obtained through tests, interviews, and questionnaires. Each data collection method has different purposes and instruments according to the needs of the research. Fraction Fun learning media. This test was conducted with reference to the ability indicators to be achieved in learning fractions. Indicators measured in the test include: 1) Ability to compare fractions, 2) Converting fractions to other forms (ordinary fractions to decimals and vice versa), 3) Solving story problems related to the concept of fractions. The examples of test questions given to students include: 1) $\frac{2}{6}, \frac{...}{...}, \frac{4}{6}, \frac{5}{6}$ The right fraction to fill the dots above to be the right order is?, 2) Bagas cut the watermelon into 8 pieces. Bagas then eats two parts of the watermelon. Then the value of the watermelon eaten by Bagas when written in fraction form is?

Second, data collection through interviews was used to obtain qualitative information about the use of media in the learning process, as well as to find out the perceptions and responses of teachers and students to the developed media. The type of interview used in this research is semi-structured, where the researcher has prepared the main questions, but still gives freedom to respondents to provide open and in-depth answers. Examples of interview questions asked to teachers and students include: 1) The material presented is easy for students to understand, 2) Increasing students' understanding of the concept of fractions, 3) This media can be used in various learning strategies, and others.

Third, data collection is done through questionnaires given to material experts, media experts, teachers, and students to determine the level of feasibility, practicality, and acceptability of the media. This questionnaire was prepared using a Likert scale with a score range of 1-5 (1 = strongly disagree, 5 = strongly agree) and includes aspects of content feasibility, appearance, ease of use, and media attractiveness.

2.4. Data Analysis

The validation questionnaire contained aspects of media feasibility and attractiveness with a Likert scale of 1-5. To assess the practicality of the media by teachers and students, a Likert scale was used. The scores from the assessment sheet were then processed to determine the level of validity and practicality of the media. The number of statements, minimum score, and ideal maximum score on each assessment sheet can be seen in Table 1.

Table 1

Maximum and minimum scores

Statement	Total	Minimum Score	Maximum Score
Material Expert	13	13	65
Media Expert	17	17	85
Teacher Assessment	17	17	85
Student Assessment	17	17	85

The formula used to calculate the percentage of the results of the assessment sheet by media experts, material experts, teachers, and student assessments for Box Fraction Fun learning media is as follows.

$$P(s) = \frac{S}{N} \times 100\%$$

With P(s) = Sub indicator, S = Overall value of each indicator, N = total maximum value

The results of the validity test by media experts, materials, and practicality tests are classified based on the percentage range as follows: 81%-100% included in the Very Valid category, 61%-80% Valid, 41%-60% Quite Valid, 21%-40% Less Valid, and 0%-20% Invalid (Alamanda & Zainil, 2024).

The pre-test and post-test results of fraction-related materials were calculated using the formula:

$$Value = \frac{score\ obtained}{maximum\ score} \times 100$$

The results obtained in increasing the effectiveness of the media can be seen with N-gain using the formula:

$$G = \frac{post - pre}{G\max pre}$$

Then the results obtained are categorized using the categories in Table 2.

Table 2
Effectiveness criteria

G	Criteria
$g > 0{,}7$	High
$0{,}3 \leq g \leq 0{,}7$	Moderate
$g < 0{,}3$	Low

Source: (Silvana et al., 2021)

Other data collection techniques include validation questionnaires, practicality assessments, tests, and interviews. The validation questionnaire was used to measure the extent to which the developed media met the eligibility criteria. Practicality assessment was used to determine the ease of use of the media by teachers and students. Furthermore, tests were conducted in the form of pre-test and post-test to evaluate the level of student understanding in understanding the material using the learning media that had been developed. Interviews were conducted to explore students' opinions regarding the extent to which learning media helped their learning process. The data analysis technique used is descriptive quantitative based on the results of validation, practicality, effectiveness and observations made during the research process.

3. Results and Discussion

3.1 Results

This media research and development follows the ADDIE model which consists of five stages, namely analysis, design, development, implementation, and evaluation. The explanation of the results of the discussion in this study includes these five stages as follows.

3.1.1 Analysis

Analysis before creating a learning media is the initial stage to ensure that the media developed is in accordance with learning needs. Based on the results of interviews with one of the subject teachers, it was revealed that the use of teaching aids in the classroom is still very limited. Teachers tend to rely on lecture methods due to time constraints and the lack of available resources, which results in students receiving more abstract explanations without concrete representations. Furthermore, interviews with several students confirmed that they rarely use teaching aids during fraction lessons, which makes it difficult for them to fully understand the concept. Many students expressed that learning fractions without concrete media is confusing and often leads to misconceptions, such as distinguishing between numerators and denominators or understanding that fractions are parts of a whole.

Based on the analysis, it was found that many students do not understand that fractions are part of the whole. This situation is caused by the abstract nature of fractions, elementary school students are still at the concrete and operational stage of cognitive development. At this age, students tend to understand concepts that are concrete or can be observed and touched directly. This condition is reasonable considering that elementary school students are mostly at the concrete-operational stage of cognitive development according to Piaget (aged around 7-11 years), which at this stage their thinking ability is very dependent on real objects and concrete events, and not yet able to understand concepts that are too abstract (Hayat et al., 2024).

In addition, the concept of fractions requires a strong understanding of basic math skills, such as division, number ordering, and the relationship between parts and wholes. Many students do not fully

understand the meaning of numbers in the context of fractions, such as distinguishing between numerators and denominators, or why fractions with larger numbers can have smaller values. This often leads to confusion, especially if not explained gradually and contextually. Other contributing factors are the lack of variety in learning methods, minimal use of visual media or teaching aids, and limited time for practice. A study by Siller & Ahmad (2024) showed that the integrated use of concrete and virtual manipulatives was very effective in improving students' understanding of fraction operations such as addition and subtraction.

From the results of this analysis, researchers provide solutions in the form of learning media, namely Box Fraction Fun (BFF). This learning media is specifically designed to help elementary school students understand the concept of fractions through a game-based approach. This media is in the form of an educational box that contains various interactive components that allow students to learn actively, creatively, and fun. By combining game elements and math concepts, students will understand concretely through direct manipulation. In use, this media utilizes various game elements such as question cards and physical fraction puzzle pieces that function to make it easier for students to understand the concept of fractions visually and practically. In addition, this media is equipped with fraction materials to facilitate students before starting the game. Thus, this media is expected to build students' stronger understanding of fraction material. This is in line with the findings of Wilkie & Roche (2023) who stated that the use of continuous and discrete representations with manipulatives allows students to experiment directly, which significantly accelerates the understanding of fraction concepts compared to static models such as images.

3.1.2 Design

This learning media was inspired by a video on the TikTok platform (https://vt.tiktok.com/ZS6wt3T91/) so that researchers developed it into a learning media named *Box Fraction Fun* or BFF. Researchers gave this media the name *Box Fraction Fun* or BFF with the hope that students are motivated to make learning more fun. Box Fraction Fun is designed using materials that are easy to find such as cardboard and colored paper and researchers designed a block-shaped box design. Next, the researcher designed the images for the front and back sides, with the aim of making the game into two missions. In the first mission, it only focuses on matching fractions with real visuals in the form of existing puzzles using food fractions. Then, in the second mission, it began to focus on comparison and fraction operations using problem cards. The researcher created a character-based design to attract students' attention as shown in Figures 2.

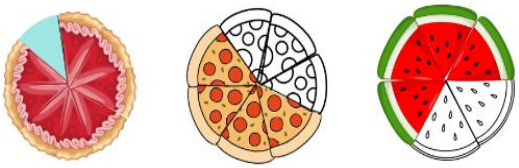
Figure 2
Missions

Furthermore, in the first mission, researchers used three types of food that had space to be numbered so that it could be a benchmark for students to determine the food *puzzle* to be taken. This makes students more interested in choosing food according to the type they want, food choices are designed as shown in Figure 3. Furthermore, researchers design designs that will become *puzzles* from the numbers contained in certain foods, can be seen as Figure 4.

International Journal of Didactic Mathematics in Distance Education
Volume 2, Issue 2, pp. 189 – 206, E-ISSN: 3047-9207
https://jurnal.ut.ac.id/index.php/ijdmde

Figure 3
Food design

Figure 4
Food puzzles



After designing the design for the first mission, the researcher created a design for the second mission that uses question cards. It can be seen from Figure 5 that the design of the question card has been made. This question card will be placed on the right side of the box. Then, the researcher made the answer for this question card. Students will find the fraction that is equal to the answer of the question. The design for the answer of the question card as shown in Figure 6.

Figure 5
Problem card

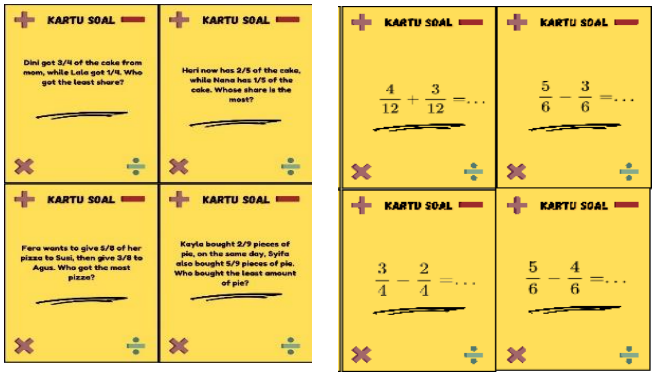
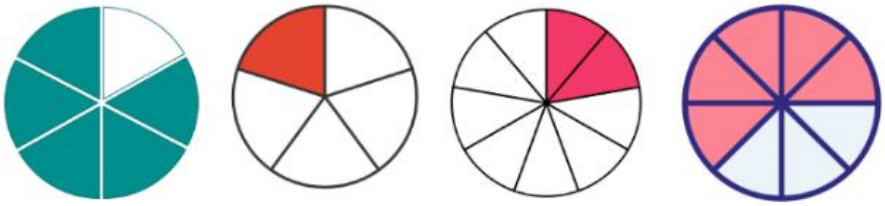


Figure 6
Puzzle for question cards



After designing all the missions, the researcher made the rules of the game for all missions in a design that will be attached to the puzzle boxes and other play tools. The design of the game rules can be seen in Figure 7. The researcher made a star design as a reward as shown in Figure 8 if the student is

International Journal of Didactic Mathematics in Distance Education
Volume 2, Issue 2, pp. 189 – 206, E-ISSN: 3047-9207
https://jurnal.ut.ac.id/index.php/ijdmde

correct in answering the question card. This design is made to increase the motivation of students, so that teachers can give awards to students who have the most stars.

Figure 7

Rules of the game

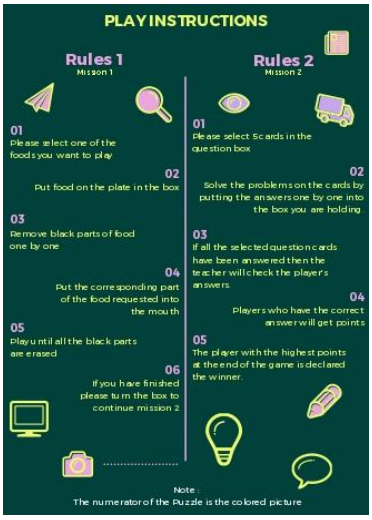


Figure 8

The stars

Finally, researchers create material assistance that is designed to help students remember what concepts have been learned before, can be seen as Figure 9, while Figure 10, shows a QR code that can be accessed by students. The content in it is in the form of help material like the one in Figure 9.

Figure 9

Content help material

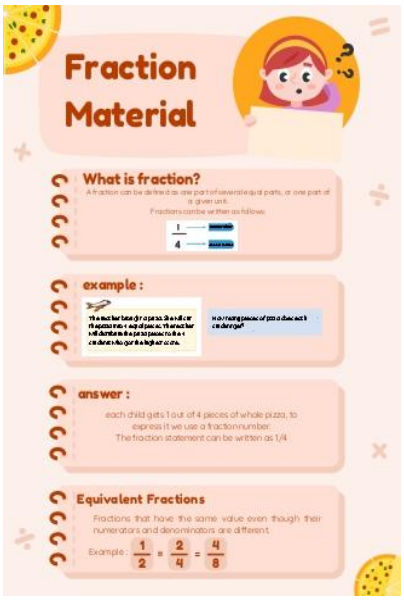


Figure 10
QR codes

3.1.3 Development

The next stage is the development of the initial design of *Box Fraction Fun* learning media. At this stage, validation of the design, materials and media designed in the previous stage is carried out. The purpose of the development stage is to create learning media that can be applied in the learning process. Before conducting media production, researchers first submitted the initial concept of *Box Fraction Fun* learning media to the supervisor to then be given input and suggestions on the product to be developed. After conducting validation, researchers began to produce the product to be developed. Researchers began to prepare tools and materials that would be used to produce *Box Fraction Fun* learning media.

a) Peer Validation

After the media development process has run 35%, researchers conduct validation tests with peers. Input from peers during this validation process will be an improvement to the learning media before entering a more formal validation process. Some input and suggestions from peers, namely 1) finalize the concept of the material to be conveyed. 2) the character design on this media is made more interesting. 3) change the box wrapper to plain color paper. 4) add question cards to test students' level of understanding.

Figure 11
Peer validation

After the peer validation process, researchers began to make improvements based on feedback from peers. The development of learning media begins with finalizing the concept of the material to be delivered. After that, visual designs such as characters, materials, and *rewards* are made, printed, and laminated to strengthen the appearance and durability. The tools used include scissors, cutter, double-sided tape, and ruler. Materials needed include thick cardboard, mangosteen paper, laminated designs, markers and velcro or shirt adhesive.

Next, prepare a cardboard box the size of the design. Make a "material aid" section out of cardboard pieces wrapped in mangosteen paper, and attach the laminated design. Make a hole in the main box to insert this section, and add a support to keep it from pulling out completely. Then make a handle on the outside to make it easier to pull out.

Close the box, wrap it in colored paper, and stick the design on the front and back. Punch holes in the design according to the marks, and make a drawer at the bottom of the box to access the *puzzle*. Also make a container for the question cards on the left side of the box, then wrap it to make it more neat. Add a decoration such as a *QR code* on the side. Cut out all the *puzzle* designs and question cards and store them in a separate box wrapped in colored paper. Attach the "food" type elements using velcro, and place the question cards in the prepared container. Here is the final look of the *Box Fraction Fun* learning media production stage.

Figure 12
Mission 1 and Mission 2


Figure 12 is the results of the development carried out by researchers. Figure 12 displays mission 1 and mission 2 which will support students in learning the opportunity material presented in the *Box Fraction Fun* learning media.

b) Media Validation Test of *Box Fraction Fun*

After the production process is carried out, then the validity test is carried out on the results of product development. Validation was carried out by two material experts and two media experts. This validation test was carried out during the media exhibition at the IDM (*International Day of Mathematics*) 2025 celebration located at Sriwijaya University. The following is the validity assessment from two material experts on the *Box Fraction Fun* learning media that has been developed.

Table 3
Validity assesment by material experts

Validity Assessor	Score
Material Expert 1	48
Material Expert 2	56
Average score	52
Average Score Percentage	80%
Validity Category	Valid

The material expert validation sheet amounted to 13 statements measured on a Likert scale. Based on the results of validity by material experts in Table 3, *Box Fraction Fun* learning media falls into the valid category. It means that the learning topics used in *Box Fraction Fun* learning media have fulfilled the applicable curriculum and material coverage.

Table 4
Validity assessment by media experts

Validity Assessor	Score
Media Expert 1	81
Media Expert 2	70
Average score	76
Average Score Percentage	89.4%
Validity Category	very valid

The media expert validation sheet totals 17 statements measured on a Likert scale. It can be seen from the results of validity by media experts in Table 4, *Box Fraction Fun* learning media falls into the category of very valid. It is stated that the design that has been designed by researchers in developing media is in accordance with the needs of students.

As attached in Tables 3 and 4, this *Box Fraction Fun* learning media can be categorized as feasible as learning media in the mathematics learning process. However, there are suggestions and input from both experts to make the learning media look better. Such as the addition of work instructions to be more directed to mathematical concepts and the addition of levels when working on problems, so that the limits of students' abilities can be seen. Then the researcher made progressive revisions by considering suggestions from material and media experts so that the learning media was more ready to be implemented.

Figure 13 is a documentation of the development product on display at the Sriwijaya University IDM 2025 celebration.

Figure 13
IDM exhibition


c) Practicality Test Evaluation

After making revisions to the learning media, researchers conducted a practicality test to find out the extent to which this media can be maximally utilized and save time in learning. The following are the results of the practicality test assessment shown in Table 5.

Table 5
Precticality results of BFF learning media by teachers

Practicality Assessment	Score
Math Teacher	76
Average score	76
Average Score Percentage	89.4%
Practicality Category	Very Practical

The practicality assessment sheet amounted to 17 statements measured on a Likert scale. According to the results of the practicality test conducted by teachers in Table 5, *Box Fraction Fun* learning media falls into the very practical category. From these results it can be concluded that *Box Fraction Fun* learning media is considered easy to use, and helps in strengthening students' understanding, as well as in accordance with the learning needs in the classroom according to the teacher's perspective.

Table 6
Practicality results of BFF learning media by students

Practicality Assessment	Score
Student 1	80
Student 2	76
Student 3	78
Average Score Percentage	91.7%
Practicality Category	Very Practical

The practicality assessment sheet amounted to 17 statements measured on a Likert scale. As seen from the student practicality test results listed in Table 6, *Box Fraction Fun* learning media is in the very practical category. This result indicates that *Box Fraction Fun* learning media is considered easy to understand and helps students understand the concept of the material.

Based on the results of the two assessment sheets on the practicality of the media, the conclusion is that this media is included in the category of learning media that is efficient in supporting teachers in the interactive mathematics learning process. This reinforces the results of the previous validation, this media is proven to be not only theoretically appropriate, but also effectively applied in classroom learning practices. The practicality of this media is reflected in its ease of use, attractive appearance, and its ability to facilitate students' understanding of fraction material in a more concrete and fun way. Thus, *Box Fraction Fun* learning media has a significant opportunity to become an alternative mathematics learning tool that is innovative, interactive, and in accordance with learning needs at the elementary school level.

3.1.4 Implementation

The implementation stage is where the *Box Fraction Fun* (BFF) learning media begins to be applied in real learning situations. In this process, this media is tested on students to measure its effectiveness in helping them understand the concept of fractions. In the first stage, the implementation is done individually with teacher supervision. Students interact directly with the learning media through the activity of selecting and matching food pieces (pizza, pie, and watermelon) that represent fraction values. Students are given a picture of a fraction with parts to be removed and then replace it with the corresponding food. This activity is conducted in the classroom with teacher support to provide direction and clarification when needed.

After receiving feedback from the first stage of implementation, the second stage of implementation was continued. At this stage, the addition of interactive elements and more complex challenges, the media was tested on individual students to solve fraction challenges in the form of questions. In stage 2, the Box Fraction Fun media is equipped with question cards, an answer box at the back of the box, and a storage drawer for puzzles and other tools. Students can use material aids such as concept cards and QR codes to support the learning process.

During the implementation, the teacher monitored student engagement, ease of use of the media, and how students responded to the challenges. Students seem more enthusiastic and active in learning because of the fun and contextual approach. In addition, the reward system in the form of giving stars for each correct answer also adds to students' motivation in solving problems. Overall, the implementation of Box Fraction Fun media shows that the application of learning media in the form of games can deepen students' understanding of fraction concepts more concretely, as well as improve skills in critical thinking, accuracy, and collaboration. Documentation of student trials can be seen through the following link drive: https://drive.google.com/drive/folders/1Vs3BhrugEUeSgxuPChjiFfMfl8iYbW6a

The last stage of this research is the evaluation stage. Evaluation is carried out as a step to assess the extent to which the learning media that has been developed is successful and in accordance with the development objectives that have been set previously. From the results of the trial use of the media and interviews with three students who are research subjects, it can be concluded that students have a better understanding of the concept of fractions after utilizing the media that has been designed. This is reinforced based on the results of the pre-test and post-test carried out by students during the trial stage. At this stage, an assessment of students' abilities is carried out with the use of Box Fraction Fun media to see whether the media that has been developed is successful in improving students' understanding of fraction material.

Figure 14

Implementation process

The last stage of this research is the evaluation stage. Evaluation is carried out as a step to assess the extent to which the learning media that has been developed is successful and in accordance with the development objectives that have been set previously. From the results of the trial use of the media and interviews with three students who are research subjects, it can be concluded that students have a better understanding of the concept of fractions after utilizing the media that has been designed. This is reinforced based on the results of the pre-test and post-test carried out by students during the trial stage. At this stage, an assessment of students' abilities is carried out with the use of Box Fraction Fun media to see whether the media that has been developed is successful in improving students' understanding of fraction material.

a) Effectiveness

The effectiveness aspect is carried out to determine whether the goals and objectives of the media that have been developed are achieved. To test this aspect, researchers conducted observations and interviews with students who became research subjects. The following are the results of student responses after testing the media that has been developed.

Interviewer: "according to you, the media used earlier helped not in the process of learning fractions?"
Student: "It helps a lot, because I can directly see the shape of the fraction. So I'm not confused anymore and I'm not bored, if I only use books, I like to be confused".
Interviewer: "according to you, did the activity make you more courageous to ask questions?"
Students: "Yes ma'am, because it feels more relaxed and like playing together".
Interviewer: "Is the media difficult to use?"
Students: "It's not difficult mom, because there are rules for using the media".

From the results of interviews that have been conducted with students, researchers concluded that this game-based learning media is effectively used in learning fraction materials. Box Fraction Fun media is able to improve the understanding of fraction concepts through visual representations and interactive activities, such as images of fractions in the form of pizza, pie, and watermelon and games in the form of question cards. Students become more active participants during the learning process.

After testing the media, students then began to complete the missions in the media that had been developed. After that, students were asked to take a *post test* to see if there was a difference before and after using the media. Based on the results of the *post test* that has been done, students no longer experience mistakes in working on questions. Students can work on *post test* questions in a short time. This is because students have fully understood the fraction material assisted by *Box Fraction Fun* learning media.

To evaluate the learning media that has been developed, researchers conducted trials using pre-test and post-test on students. The results of the *pre-test* and *post-test* are presented in Table 7.

Table 7
Student pre-test and post-test scores

Student	Pre Test Score	Post Test Score
VJ (high)	80	100
AK (Medium)	60	100
S (low)	40	95
Average	60	98.3

To obtain the value of learning outcomes, the N-Gain formula was used. From the calculation, it was found that the learning outcomes of three fourth grade students increased by 0.957 which is included in the high category (g> 0.7). The following is the calculation:

$$G = \frac{post - pre}{G \max pre} = \frac{98.3 - 60}{100 - 60} = \frac{38.3}{40} = 0.957$$

This result shows that the use of Box Fraction Fun learning media can have a positive impact on increasing students' understanding of fraction material. This finding is in line with the results of Rahadian & Raditya (2020), which shows that learning using concrete media in the form of fractional blocks also improves student learning outcomes on fraction materials in grade II elementary schools. In the study, the N-Gain obtained reached 34.16% or equivalent to the medium to high category, and was supported by an increase in student learning motivation which reached an average score of 3.91 on a scale of five (high category). This increase occurred because students can interact directly with props that are concrete and manipulative, allowing them to understand the concept of fractions visually and kinesthetically. Thus, in both Box Fraction Fun and fractional blocks media, the game-based and real object-based approach is proven to be effective in overcoming students' difficulties in understanding abstract concepts such as fractions, while encouraging increased motivation and active participation in the learning process.

The post-test results showed a significant increase in student understanding, where the average student score increased to 98.3. This increase reflects the positive effect of using the designed learning media on students' understanding. Based on the pre-test results, students with three different ability levels still do not understand how to represent fractions into pictures, and vice versa. However, they have

understood the basic concept of fractions about the position of the numerator and denominator, it's just that they are still mistaken in its application. These findings are in line with Asoy et al (2022), who found that using manipulatives in teaching fractions significantly improved elementary students' understanding, particularly in connecting symbolic and pictorial representations of fractions, as reflected in the significant difference between pre-test and post-test scores in their experimental group.

b) Practicaity Test

The practicality test of *Box Fraction Fun* media was conducted through the distribution of questionnaires after the learning took place. The questionnaire contains statements that measure the ease of use of the media, clarity of instructions, student involvement, and comfort when using the media in the teaching and learning process. The following are the results of the questionnaire that has been filled in by teachers and students.

Table 8

Practicality results of BFF learning media by teachers

Practicality Assessment	Score
Math Teacher	76
Average Score	76
Average Score Percentage	89.4%
Practicality Category	Very Practical

The practicality assessment sheet amounted to 17 statements measured on a Likert scale. According to the results of the practicality test conducted by teachers in Table 8, *Box Fraction Fun* learning media falls into the very practical category. From these results it can be concluded that *Box Fraction Fun* learning media is considered easy to use, and helps in strengthening students' understanding, as well as in accordance with the learning needs in the classroom according to the teacher's perspective.

Table 9

Practicality results of BFF learning media by students

Practicality Assessment	Score
Student 1	80
Student 2	76
Student 3	78
Average Score Percentage	91.7%
Practicality Category	Very Practical

The practicality assessment sheet amounted to 17 statements measured on a Likert scale. As seen from the student practicality test results listed in Table 9, *Box Fraction Fun* learning media is in the very practical category. This result indicates that *Box Fraction Fun* learning media is considered easy to understand and helps students understand the concept of the material.

3.2 Discussion

Based on the analysis of the two practicality assessment sheets, it can be concluded that Box Fraction Fun media is included in the category of learning media that is efficient in supporting teachers in the interactive learning process of mathematics. The practicality of this media is reflected in several aspects such as ease of use by teachers and students, attractive visual appearance, and the ability of the media to facilitate students' understanding of fraction concepts in a concrete and fun way. With its characteristics, Box Fraction Fun media has a strong potential to be an alternative mathematics learning media that is creative, interactive, and in accordance with the learning needs of elementary school students. This is in line with the results of research by Hunt et al (2023) which revealed that the use of interactive game-based curriculum can improve students' understanding of fraction concepts while fostering their interest in STEM fields through a fun and meaningful approach.

In addition, information from interviews with math teachers also showed that this media has helped students in understanding the concept of fractions. Nevertheless, the teacher provided input that some display features could still be improved to make the media look more attractive and optimal in use. In particular, the teacher highlighted that the visual designof thecharacters in the media could still be refined

to better reflect the characters of children andstrengthen the visual appeal. In addition, the placement of game elements such as questioncards and puzzle storage drawers is proposed to be more organized, so that the student interaction process becomes smoother and more efficient. These improvements will strengthenthe aesthetic appeal and make it easier for students to navigate when completing missions, ultimately improving the usability of the media in classroom learning activities. This finding is reinforced by the results of teacher assessment through an instrument containing 17 statements using a Likert scale (1-5). The percentage of practicality level obtained based on the calculation is shown in Table 8, which shows that this media obtained a total score of 89.4%. Based on this percentage, Box Fraction Fun learning media is categorized as a very practical and efficient media. This shows that the use of interactive media significantly improves students' learning achievement in fraction materials (Nazilah et al., 2025).

Observations during the pilot test also support this. Students were able to complete the missions in the media without experiencing significant difficulties, indicating that this media is easy to understand and use in a learning context. Furthermore, the learning media developed proved to have a positive impact on student learning achievement, as seen from the increase in scores between the pre-test and post-test results. This increase shows that the media is able to increase the effectiveness of learning and help students understand the material better. This finding also reinforces the opinion that the use of interactive learning media can improve students' understanding and create a more meaningful and enjoyable learning process. The results of this study are in accordance with the findings of previous research, which found that interactive learning media can improve student learning outcomes. In this study, Box Fraction Fun media was proven to not only make it easier for students to understand fraction material, but also increase learning outcome scores from pre-test to post-test. This shows that the use of interactive media can create a more effective, fun, and meaningful learning process (Putri et al., 2022).

In terms of theory, the results of this study are in line with Piaget's view of constructivism which emphasizes the importance of learning that takes place through direct experience and social interaction. This approach prioritizes strategies such as problem solving, activity-based projects, real experiments, and group discussions to create an active and meaningful learning environment (Erawati & Adnyana, 2024). Box Fraction Fun media allows students to engage in explorative activities and complete missions, which encourages learning through real experiences. This finding also supports the dual coding theory proposed by Paivio (1986), which states that the learning process will be more effective if information is conveyed through a combination of verbal and visual (Samburskiy, 2020). The presentation of fraction material in this media visually and interactively makes it easier for students to understand and process information. Thus, the results of this study are not only supported by previous findings, but also reinforced by modern learning theories that emphasize the importance of the role of interactive media in supporting the optimal learning process. This is also in line with the opinion of Putri et al (2022) who stated that the use of interactive learning media can improve student achievement and deepen understanding of the subject matter (Putri et al., 2022).

However, it should be noted that this study has some limitations. First, the implementationof Box Fraction Fun media was only conducted in one primary school with a limited number of subjects, so the results cannot be generalized to a wider population. Secondly, the long-termeffectiveness of using this media has not been thoroughly analyzed. Therefore, it is recommended that further research be conducted on a larger scale and over a longer periodof time to evaluate the ongoing impact of using this media on students' understanding of mathematics concepts.

4. Conclusion

Based on the results of research and development that has been carried out, Box Fraction Fun learning media shows a high level of feasibility. The evaluation results from two material experts and two media experts who are lecturers of the Mathematics Education Study Program at Sriwijaya University show that this media meets the eligibility standards. The average validation results from material experts reached 80% which is included in the valid category, while the validation results from media experts reached 89.4% which is included in the very valid category. Thus, Box Fraction Fun learning media is declared suitable for use in grade IV elementary school.

From the aspect of practicality, this media obtained a positive response from users. The assessment results of grade IV teachers in one of the Public Elementary Schools in Palembang showed an average of 89.4% with very practical criteria, while student responses reached 91.7% which was also included in the very practical category. From the effectiveness aspect, there was an increase in score of 0.957 after using media in educational activities, indicating that this media is effective in enhancing students' comprehension of fraction concepts. The implication of this research shows that game-based learning media such as Box Fraction Fun can be an innovative alternative in the process of learning mathematics in elementary schools, especially in conveying abstract fraction concepts to be more concrete and fun. This learning media also holds the potential to enhance students' motivation and foster greater active engagement in the learning process.Students at the primary school level showed significantly increased engagement and comprehension.

A recognized limitation of this study pertains to the fact that the implementation of the media was confined to a single primary school in Palembang and involved a limited sample size. Therefore, caution is advised when generalizing the findings to other educational settings. In addition, the long-term effectiveness of the media has not been evaluated in depth. Future research is recommended to test this media in various school contexts and over a longer period of time to get more comprehensive results. Wider testing is important because the characteristics of students, teachers and the learning environment can vary greatly between schools. Thus, testing in different contexts will provide a more comprehensive picture of the flexibility and adaptability of this media.

Overall, this research contributes not only to more fun and concrete fraction learning practices, but also enriches the study of interactive media development in the realm of basic mathematics education. Innovations such as Box Fraction Fun open up new opportunities for educators and researchers to bridge the abstraction of mathematical concepts with more contextual and meaningful learning experiences.

Author Contribution

Author 1: Conceptualization, Writing - Original Draft;
Author 2: Writing - Review & Editing, Formal analysis, and Methodology;
Author 3: Writing – Review & Editing, Visualization;
Author 4: Writing – Review & Editing;
Author 5: Writing –Corresponding, Review & Editing
Author 6: Writing –Review
Author 7: Writing –Review
Author 8: Writing –Review

Conflict of Interest

The authors declare no conflict of interest.

5. References

Alamanda, L., & Zainil, M. (2024). Pengembangan media pembelajaran berbantuan aplikasi Math City Map pada materi luas bangun datar di kelas IV SD [Development of learning media assisted by the math city map application on the area of plane figures material in fourth grade elementary school]. *Pendas: Jurnal Ilmiah Pendidikan Dasar, 9*(3), 361-372.

Allen, W. C. (2006). Overview and evolution of the ADDIE training system. *Advances in Developing Human Resources*, *8*(4), 430–441. https://doi.org/10.1177/1523422306292942

Anggoro, B. S., Dewantara, A. H., Suherman, S., Muhammad, R. R., & Saraswati, S. (2024). Effect of game-based learning on students' mathematics high order thinking skills: A meta-analysis. *Revista de Psicodidactica*, *xxxx*, 500158. https://doi.org/10.1016/j.psicod.2024.500158

Asoy, E., Boston, E., Madagmit, I. M., & Bacatan, J. (2022). Manipulatives in learning fraction for improving first-year elementary students' understanding. *Indonesian Journal of Teaching in Science*, *2*(2), 175–182. https://doi.org/10.17509/ijotis.v2i2.50147

Azzahra, P., Sundari, O., Ramasanti, P. A., Ananta, G. P., Susanti, E., Lesmana, H., Meryansumanyeka, & Zulkardi. (2024). Cak ingkling fibonacci: alat peraga dalam meningkatkan pemahaman konsep bilangan fibonacci siswa SMP [cak ingkling fibonacci: a teaching aid to enhance junior high school

students' understanding of the fibonacci number concept]. *FIBONACCI: Jurnal Pendidikan Matematika dan Matematika, 10*(1), 77-88. https://doi.org/10.24853/fbc.10.1.77-88

Beşaltı, M., & Kul, Ü. (2021). Effects of a Game-Based app on primary students' self efficacy and achievements in learning fractions during distance education. *Turkish Psychological Counseling and Guidance Journal*, *11*(63), 505–520. https://doi.org/10.17066/TPDRD.1051383

Bhatia, P., Diagon, S., Langlois, E., William, M., Prado, J., & Gardes, M.-L. (2022). Impact of a game-based intervention on fraction learning for fifth-grade students: A pre-registered randomized controlled study. *Journal of Computer Assisted Learning*, *39*, 49–62. https://doi.org/10.1111/jcal.12726

Erawati, N. K., & Adnyana, P. B. (2024). Implementation of Jean Piaget's Theory of constructivism in learning: A Literature Review. *Indonesian Journal of Educational Development*, *5*(3), 394–401. https://doi.org/10.59672/ijed.v5i3.4148

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1. https://doi.org/10.11648/j.ajtas.20160501.11

Farra, N. K. Al, Belbase, S., Tairab, H., Qablan, A., Opoku, M. P., & Safi, S. K. (2024). Impact of videos and traditional teaching methods on fifth grade students' achievement in fractions. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(12), em2544 https://doi.org/10.29333/ejmste/15658

Hastutik, W. (2021). Pemanfaatan media belajar berbasis lingkungan untuk meningkatkan kemampuan siswa menulis teks berbentuk greeting card. *Jurnal Pengabdian Pendidikan Masyarakat*, *2*(1), 48–55. https://doi.org/10.52060/jpm.v2i1.502

Hayat, F., Khan, M., Ahmad, S., Kamran, M., & Maleeha. (2024). Exploring the characteristics of concrete operational stage among primary school students. *Qlantic Journal of Social Sciences and Humanities*, *5*(1), 124–132. https://doi.org/10.55737/qjssh.786349315

Hriadi, A., Wartini, B. S., Sari, D. P., Firdaus, R. A., Meidi, R., & Susanti, E. (2024). Pengembangan alat peraga Mathdoku 5x5 untuk meningkatkan kemampuan logika siswa. *Jurnal Tadris Matematika, 7*(1), 145–158. https://doi.org/10.21274/jtm.2024.7.1.145-158

Hunt, J., Taub, M., Duarte, A., Bentley, B., Womack-Adams, K., Marino, M., Holman, K., & Kuhlman, A. (2023). Elementary teachers' perceptions and enactment of supplemental, game-enhanced fraction intervention. *Education Sciences*, *13*(11). https://doi.org/10.3390/educsci13111071

Kholil, M., & Zulfiani, S. (2020). Faktor-faktor kesulitan belajar matematika siswa Madrasah Ibtidaiyah Da'watul Falah, Kecamatan Tegal Limo, Kabupaten Banyuwangi [Factors of mathematics learning difficulties of students at Da'watul Falah Elementary School, Tegal Limo District, Banyuwangi Regency]. *EDUCARE: Journal of Primary Education*, *1*(2), 151–168. https://doi.org/10.35719/educare.v1i2.14

Lampropoulos, G., Keramopoulos, E., Diamantaras, K., & Evangelidis, G. (2022). Augmented reality and gamification in education: a systematic literature review of research, applications, and empirical studies. *Applied Sciences (Switzerland)*, *12*(13). https://doi.org/10.3390/app12136809

Malaluan, J., & Andrade, R. (2023). Contextualized question-embedded video-based teaching and learning tool: a pathway in improving students' interest and mathematical critical thinking skills. *International Journal of Science, Technology, Engineering and Mathematics*, *3*(2), 39–64. https://doi.org/10.53378/352990

Marleni, A. J., Friansah, D., & Satria, T. G. (2021). pengembangan media pembelajaran math bingo pada mata pelajaran matematika materi pecahan kelas IV SD [Development of math bingo learning media in mathematics subject on fraction material for fourth grade elementary school students]. *AULADUNA: Jurnal Pendidikan Dasar Islam*, *8*(2), 160. https://doi.org/10.24252/auladuna.v8i2a4.2021

Mashuri, S. (2019). *Media Pembelajaran Matematika*. Yogjakarta: Deepublish.

Nadirah, A., Pertiwi, A. N., Kasari, M., Sapitri, N. B., Susanti, E., Zulkardi, & Meryansumayeka. (2024). Development of "X-Math" game-based learning media to increase student's mathematics learning interest. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *13*(2), 434. https://doi.org/10.24127/ajpm.v13i2.8700

Nadirah, A., Pertiwi, A. N., Kasari, M., Sapitri, N. B. S., Susanti, E., Zulkardi, & Meryansumayeka, M. (2024). Development of mathematics learning media on geometry material to increase students' interest in learning. *Jurnal Pendidikan Matematika, 7*(2), 83–92. https://doi.org/10.30598/jupitekvol7iss2pp83-928700

Nazilah, V. R., Sriwijayanti, R. prastiwi, & Wardana, L. A. (2025). The effect of interactive learning media based on mathplayground on the learning outcomes of the students of fraction material class IV SDN Kedung Dalem III. *International Journal of Educational Technology and Society*, *2*(1), 122–130. https://doi.org/10.61132/ijets.v2i1.283

Putri, D. N. S., Islamiah, F., Andini, T., & Marini, A. (2022). Analisis pengaruh pembelajaran menggunakan media interaktif terhadap hasil pembelajaran siswa sekolah dasar [Analysis of the influence of learning using interactive media on elementary school students' learning outcomes]. *Pendidikan Dasar Dan Sosial Humaniora*, *2*(2), 367-375. https://doi.org/10.53625/jpdsh.v2i2.4290

Rahadian, B., & Raditya. (2020). The use of fractional blocks to improve mathematics for second grade elementary school students at South Bangka Indonesia. *International Journal of Innovative Science and Research Technology*, *5*(12), 189–197. https://doi.org/10.48550/arXiv.2103.02447

Saleh, M. S., Syahruddin, Saleh, M. S., & Sahabuddin, I. A. (2023). *Media Pembelajaran* (1st ed.). Purbalingga: Eureka Media Aksara. https://repository.penerbiteureka.com/publications/563021/media-pembelajaran

Salsabila, N. H., Azmi, S., & Lu'luilmaknun, U. (2022). Instructional multimedia with local context oriented to numeracy skills: practicality and effectiveness. *Journal for the Mathematics Education and Teaching Practices*, *3*(2), 101–109.

Samburskiy, D. (2020). The effect of a dual coding technique on idiom interpretation in ESL/EFL learners. *International Journal of Instruction*, *13*(3), 187–206. https://doi.org/10.29333/iji.2020.13313a

Sari, D. N., Siregar, D. A., Manullang, G. E., Gultom, I. A., & Purba, N. F. (2024). Peran media pembelajaran dalam mengatasi masalah siswa SD pada pembelajaran matematika kelas VI di SDN 060848 Durung [The role of learning media in overcoming elementary school students' problems in learning mathematics in grade VI at SDN 060848 Durung]. *Jurnal Pendidikan Tambusai*, *8*(3), 41906–41910. https://jptam.org/index.php/jptam/article/view/20245

Siller, H. S., & Ahmad, S. (2024). The effect of concrete and virtual manipulative blended instruction on mathematical achievement for elementary school students. In *Canadian Journal of Science, Mathematics and Technology Education* (Issue December). Springer International Publishing. https://doi.org/10.1007/s42330-024-00336-y

Silvana, A. W., Utomo, D. P., & Ummah, S. K. (2021). The effectiveness of linear system media on the three variable linear equation learning system. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(3), 1623. https://doi.org/10.24127/ajpm.v10i3.3832

Sitepu, E., Natasya, L. M., Sitopu, J. W., Charolina, T., & Mardiati. (2024). Enhancing student ngagement and academic performance through gamification-based learning in elementary mathematics education. *Journal Basic Science and Technology*, *13*(3), 121–131. https://iocscience.org/ejournal/index.php/JBST/article/view/5661

Ulfah, T. A., Wahyuni, E. A., & Nurtamam, M. E. (2021). Pengembangan media pembelajaran permainan kartu uno pada pembelajaran matematika materi satuan panjang. *Prosiding Seminar Nasional Matematika Dan Pembelajarannya*, *3*(3), 955–961. https://doi.org/10.31219/osf.io/qt4mv

Wilkie, K. J., & Roche, A. (2023). Primary teachers' preferred fraction models and manipulatives for solving fraction tasks and for teaching. *Journal of Mathematics Teacher Education*, 26, (6), 45-67. https://doi.org/10.1007/s10857-022-09542-7

Zhang, L., Shang, J., Pelton, T., & Pelton, L. F. (2020). Supporting primary students' learning of fraction conceptual knowledge through digital games. *Journal of Computer Assisted Learning*, *36*(4), 540–548. https://doi.org/10.1111/jcal.12422

Zhou, X., Shu, L., Xu, Z., & Padrón, Y. (2023). The effect of professional development on in-service STEM teachers' self-efficacy: a meta-analysis of experimental studies. *International Journal of STEM Education*, *10*(1). https://doi.org/10.1186/s40594-023-00422-x