

DEVELOPMENT OF PADI PROPS (COMPARISON BOARD) TO IMPROVE CONCEPT UNDERSTANDING OF JUNIOR HIGH SCHOOL STUDENTS

Vina Pandu Winata¹, Luluk Faridah², Abdur Rohim^{3*}

^{1,2,3*} Universitas Islam Darul 'Ulum, Lamongan, Indonesia

* Corresponding author. Jln. Airlangga 03 Sukodadi, 62253, Lamongan, Indonesia.

E-mail: vinapandu892@gmail.com¹
lulukfaridah@unisda.ac.id²
rohim@unisda.ac.id^{3*}

Received March 13, 2025; Received in revised form March 25, 2025; Accepted March 28, 2025

ABSTRACT

Students' understanding of mathematical concepts in junior high school, particularly in the topic of ratios, is still relatively low because they have difficulty visualizing the relationships between values. Therefore, a teaching aid is needed to help facilitate the understanding of this concept. The purpose of this study is to determine the validity, effectiveness, and practicality of the development of the PADI (Comparison Board) teaching aid in enhancing the conceptual understanding of junior high school students with the assistance of Quizizz. This research follows the R&D approach using the 4D model. This study involved 27 students of class VIIIE. This study employed validation questionnaires, response questionnaires, and tests as research instruments. The researcher used three data analysis techniques: validity, effectiveness, and practicality of the teaching aid. The results of this study are based on the average validation score from three experts, which was 85.91%, categorized as "Valid." The students' test results showed a classical completeness score of 85.18% of the total number of students, categorized as "Effective." The student and teacher response questionnaires yielded percentages of 88.14% and 100%, respectively, falling into the "Practical" category. The development of the PADI teaching aid has proven to help students understand the concept of ratios in a concrete and enjoyable way. In addition, the use of validated teaching aids supported by technology such as Quizizz can be an innovative alternative to improving the quality of mathematics learning in schools.

Keywords: concept comprehension; development; quizizz; teaching aids.

ABSTRAK

Pemahaman konsep matematika siswa SMP pada materi perbandingan masih tergolong rendah karena siswa mengalami kesulitan dalam memvisualisasikan hubungan antar nilai. Oleh karena itu, dibutuhkan alat peraga yang dapat membantu mempermudah pemahaman konsep tersebut. Tujuan dari penelitian ini adalah untuk mengetahui kevalidan, keefektifan, dan kepraktisan dari pengembangan alat peraga PADI (Papan Perbandingan) dalam meningkatkan pemahaman konsep siswa SMP dengan bantuan Quizizz. Penelitian ini termasuk R&D dengan menggunakan model 4D. Penelitian ini melibatkan 27 siswa kelas VIIIE. Penelitian ini menggunakan angket validasi, angket respon, dan tes sebagai instrumen penelitian. Peneliti menggunakan tiga teknik analisis data, yaitu kevalidan, keefektifan dan kepraktisan dari alat peraga. Hasil penelitian ini didasarkan pada rata-rata skor validasi ketiga ahli, yakni 85,91%, termasuk dalam kategori "Valid". Hasil tes peserta didik didapatkan skor ketuntasan klasikal sebesar 85,18% dari total jumlah peserta didik, yang dikategorikan "Efektif." Hasil angket respon peserta didik dan pendidik diperoleh persentase 88,14% dan 100% termasuk dalam kategori "Praktis". Pengembangan alat peraga PADI terbukti dapat membantu siswa memahami konsep perbandingan secara konkret dan menyenangkan. Selain itu, penggunaan alat peraga yang divalidasi dan didukung teknologi seperti Quizizz dapat menjadi alternatif inovatif dalam meningkatkan kualitas pembelajaran matematika di sekolah.

Kata kunci: alat peraga; pemahaman konsep; pengembangan; quizizz.



Introduction

Education is a fundamental pillar in improving the quality of human resources and serves as an important factor in shaping a knowledgeable society. The learning process is at the core of education, as it is through learning that students acquire knowledge, skills, and attitudes that support their intellectual and social development. In this context, mathematics learning plays a crucial role because it trains logical, analytical, and systematic thinking skills (Ningrum & Rohim, 2023). Education plays an important role in shaping students to be forward-thinking, tolerant, and open-minded individuals who are ready to face the future with a spirit of self-improvement (Fatimah et al., 2024). Therefore, there is a need for media that can enhancing mathematical comprehension and prepare students to face future challenges.

Learning media are tools that facilitate needs in the course of learning and assist teachers in enhancing students' knowledge (Nurfadhillah et al., 2021). Learning media play an crucial role in education, such as making the teaching and learning process more engaging, simplifying complex concepts, and improving students' understanding of mathematics. The implementation of learning media is crucial because it helps teachers explain the material more clearly, thereby enhancing students' comprehension (Gawise et al., 2022). According to Rohim & Asmana (2023), learning achievement is supported by the presence of learning media in the classroom. Appropriate learning media can optimize students' learning process in the classroom (Rohim, 2015). Therefore, educators should strive to present varied learning experiences by utilizing teaching aids in the classroom.

Teaching aids are a type of media created for educators to teach, convey concepts, principles, and lesson materials to help students understand them more easily (Telaumbanua, 2020). Complex lesson concepts that are difficult to imagine can be explained through concrete visualizations by using teaching aids, so that students not only listen to the teacher's explanation but can also see, touch, and feel the concepts being studied (Jonimar, 2020). In mathematics learning, teaching aids are essential because they help students understand complex concepts visually and manipulatively.

Understanding concepts an essential objective in studying mathematics. A good conceptual understanding enables students to solve problems effectively and efficiently (Ginanjar, 2019). The researcher selected the indicators of conceptual understanding from a study conducted by Sari et al. (2016), namely: (1) students are able to define concepts in their own words and writing, (2) students can provide problem illustrations and transform them into different forms of answers, and (3) students can identify and solve a problem. This is because these indicators are also related to Bloom's conceptual indicators, and the three mentioned indicators represent mathematical conceptual understanding.

One of the subjects that often poses difficulties for students is the topic of ratios. Based on the researcher's observation at Bustanul Hikmah Islamic Junior

High School, Lamongan, many students experienced difficulties in understanding the concept of ratios. The obstacles faced by students include the large number of formulas that are difficult to memorize and understand in this topic (Izzabella & Amin, 2021). Due to a lack of proper conceptual understanding, students often make mistakes when solving problems related to ratios (Sari, 2020). The topic of ratios is one of the most useful subjects to learn, as it is essential for understanding future mathematical concepts (Handayani et al., 2022). Conceptual understanding refers to difficulties in numerical skills, identifying, and naming the required objects. In addition, some students experience a lack of confidence, especially when asked to solve mathematical calculation problems (Khoiruddin, Vahlia, & ES, 2024). Conceptual understanding is generally hindered by insufficient comprehension of mathematical concepts and is further affected by students' lack of concentration during the teacher's explanation (Sudarman & Vahlia, 2016)

Comparison material in mathematics consists of two types: direct proportion and inverse proportion. A direct proportion occurs when one quantity increases, the other also increases, whereas an inverse proportion occurs when one quantity increases, the other decreases (Utami, 2023). A proper understanding of these two types of comparison is essential as they form the basis for solving various mathematical problems and real-life situations.

In an effort to enhance students' understanding of the concept of ratio, the researcher developed a teaching aid called PADI (Comparison Board). This tool is designed to concretely visualize the relationship between quantities in both direct and inverse proportions. In addition, to complement the learning evaluation, the researcher also utilized the Quizizz platform.

Quizizz is an interactive, game-based online learning platform that can be used to create and conduct quizzes, tests, and practice activities in the classroom (Suhartatik, 2020). This Quizizz application is used during the pre-test and post-test stages for students. The use of Quizizz in this study aims to determine the improvement in students' conceptual understanding before and after using the PADI teaching aid. The use of Quizizz is more effective because students can see their results immediately, and teachers can instantly assess the students' abilities.

The studies by Hawa & Cipta (2024), Intan & Mampouw (2021), and Utami et al. (2021) are relevant to this research because all three focus on the development of instructional media for teaching ratios. Previous studies have also demonstrated the effectiveness of manipulative media in enhancing students' understanding of mathematical concepts, as shown by Delis & Wibowo (2020) in their use of transparent mica for teaching fraction addition, and by Cahyono et al. (2024) in their use of manipulative teaching aids to reinforce mathematical concept comprehension. The product of this research is a teaching aid that can be used for various subtopics of ratios (equivalent, inverse, mixed, distance, speed, flow rate, and volume), and learning evaluation utilizes the Quizizz application as an interactive digital medium.

Nevertheless, research specifically focused on developing teaching aids for ratio-related material integrated with digital technology such as Quizizz remains limited. Based on this review, a research gap has been identified, namely the absence of concrete media in the form of specific teaching aids for ratio material supported by digital application-based evaluation. Therefore, this study aims to

develop a mathematics teaching aid called PADI (Comparison Board) to boost learners' grasp of concepts of ratio content, with the support of the Quizizz platform as an evaluation tool. The product of this research is a teaching aid covering various subtopics of ratio (equivalent ratios, inverse ratios, mixed ratios, distance, speed, flow rate, and volume), and the learning evaluation utilizes the Quizizz application as an interactive digital medium. It is expected that the results of this study will serve as an innovative and practical alternative for mathematics learning media in junior high schools.

Research Methods

This research falls under Research and Development (R&D) using the 4D model, which consists of four sequential stages in developing teaching aids: define, design, development, and disseminate. The 4D model is one of the most popular development models in the field of education.

This research was conducted at Bustanul Hikmah Islamic Junior High School, Kembangbahu District, Lamongan, with 27 students of class VIIIE as the subjects. The object of the research was the PADI (Comparison Board) teaching aid aimed at improving students' conceptual understanding. The data for this research were obtained from various instruments, including interviews, validation questionnaires, response questionnaires, and tests.

There are three data analysis techniques, namely the validity, effectiveness, and practicality of the PADI teaching aid. The data analysis techniques used in this research are as follows Table 1:

Table 1. Research data analysis techniques

No	Aspects Assessed	Instrument	Observed Data	Respondent
1	Validity	Validation questionnaire	The validity of the PADI teaching aids	Subject matter expert, Teaching aid designer, Learning expert
2	Effectiveness	Test	Completion of student test results	Students
3	Practicality	Survey of student and educator responses	Student response and educator response.	Students and educators

Based on Table 1, the data analysis technique is obtained from questionnaire and test instruments. There are two types of questionnaires: expert validation questionnaires and response questionnaires. The validation questionnaire is used to measure validity, while the response questionnaire is used to measure the practicality of the teaching aid. Meanwhile, the test instrument is used to measure the effectiveness of the teaching aid in improving conceptual understanding. The test instrument uses Quizizz as it is more efficient and effective.

The following are the steps for developing the PADI (Comparison Board) teaching aid based on the 4D model in a procedural manner can be seen in Figure 1 below:

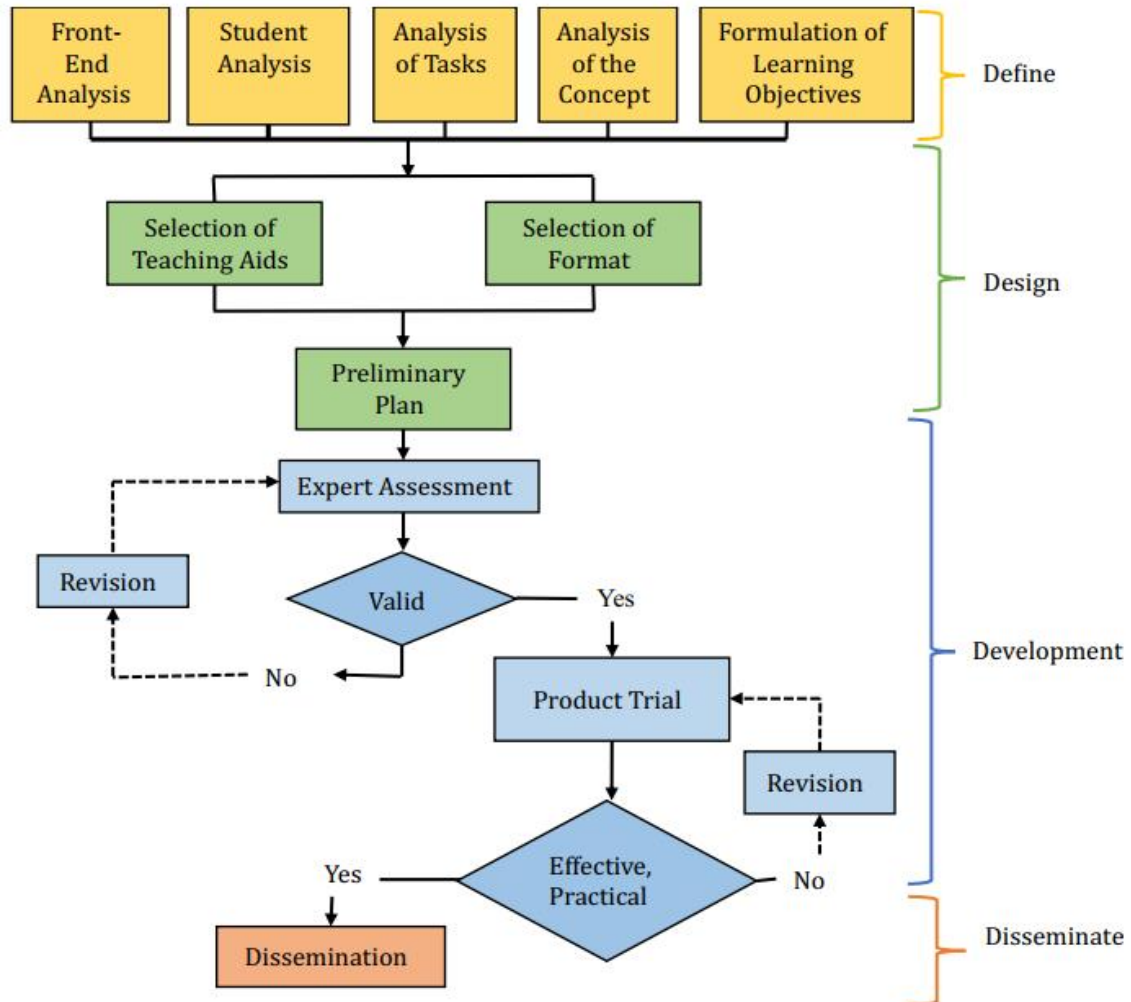


Figure 1. 4D Model R&D Procedure

Based on Figure 1, a product is considered valid if there are no more revisions from the validation expert's assessment. A product is considered effective and practical if, after being tested, no further revisions are needed. Once it is deemed effective and practical, the product can be used in other classes or schools.

Validity Analysis of the PADI (Comparison Board) Teaching Aid

The researcher used a Likert scale modified from Sugiyono (2021) to collect data from expert validators through a questionnaire. The purpose of its use was to determine the validity level of the developed teaching aid. The following are the categories of the Likert scale can be seen in Table 2 below:

Table 2. Likert scale

No	Score	Description
1	Score 5	Very Good
2	Score 4	Good
3	Score 3	Fairly Good
4	Score 2	Less Good
5	Score 1	Not Good

Based on Table 2, the Likert scale has several score levels that help respondents understand the meaning of each answer choice. These responses will be analyzed using the expert validator's assessment score calculation with Formula (1) as follows:

$$N = \frac{\sum X}{\sum X_i} \times 100\% \dots\dots (1)$$

Description:

N = Value

$\sum X$ = Total score obtained

$\sum X_i$ = Maximum total score

The results of the validity assessment were then analyzed using the criteria from Akbar (2016). The evaluation criteria from expert validators can be seen below Table 3.

Table 3. Expert validator assessment criteria

No	Final Score	Validity Categories
1	84,00 < N ≤ 100,00	Valid (can be used without any improvements)
2	68,00 < N ≤ 84,00	Valid (can be used with minor improvements)
3	52,00 < N ≤ 68,00	Less valid (can be used with major improvements)
4	36,00 < N ≤ 52,00	Not valid (cannot be used yet, requires major improvements)
5	0,20 < N ≤ 36,00	Highly not valid (cannot be used yet)

Based on Table 3, the development product of the PADI teaching aid is considered feasible for use if it has a final score above 68 up to 100. However, if the final score is less than or equal to 68, it is not yet suitable for use.

After that, the assessment results from the three validators (instructional media expert, subject matter expert, and learning expert) were analyzed using Equation (2) below.

$$Na = \frac{N1+N2+N3}{3} \dots\dots (2)$$

Description:

Na = Final Score

N1 = Validation score from instructional media expert

N2 = Validation score from subject matter expert

N3 = Validation score from learning expert

The PADI (Comparison Board) teaching aid is considered valid if the average validation score from the three validators is more than 68%.

Analysis of the Effectiveness of the PADI Teaching Aid (Comparison Board).

The effectiveness of teaching aids is measured based on students' test mastery, which is analyzed using classical learning mastery. According to Trianto (2017), learning is considered classically complete if $\geq 85\%$ of students achieve scores above the Minimum Mastery Criteria (MMC). The calculation of classical mastery is carried out using Formula (3), referring to Arikunto (2019).

$$KK = \frac{\sum ST}{n} \times 100\% \dots\dots (3)$$

Description:

KK = Classical mastery

n = Number of students

$\sum ST$ = Number of students who achieve the Minimum Mastery Criteria (MMC).

The PADI (Comparison Board) teaching aid is considered effective and suitable for use in mathematics learning if the percentage of classical mastery is $\geq 85\%$, with the MMC set at 78.

Practicality Analysis of the PADI (Comparison Board) Teaching Aid

The practicality of the teaching aid is measured based on the questionnaire responses from educators and students. The researcher used the Guttman Scale as modified from Sugiyono (2021). Table 4 below presents the score categories in the Guttman Scale can be seen in Table 4 below:

Table 4. Categories in the guttman scale

No	Description	Score
1	Yes	1
2	No	0

Based on Table 4, the Guttman scale category in this response questionnaire is used to facilitate respondents in assigning scores based on their observations during the learning process using the PADI teaching aid. The response questionnaire data is then calculated using Formula (4).

$$Questionnaire = \frac{Tse}{Tsh} \times 100\% \dots\dots (4)$$

Description:

Tse = Total score obtained

Tsh = Total maximum score

The PADI (Comparison Board) teaching aid is considered practical if the percentage of the average questionnaire score falls within the range of 50% to 100%.

Results and Discussion

The following are the results and discussion of the development of the PADI teaching aid using the 4D model.

Stage Define

The first stage in the development of the PADI teaching aid is the Define stage. The main activities in this stage include needs analysis through observation and interviews. Based on initial observations and teacher interviews, it was found

that many students have difficulty understanding the concepts of direct and inverse proportion, which often leads to errors in solving related problems. Therefore, it is necessary to develop an interactive and visual teaching aid to help students visualize and better understand these concepts. The purpose of this teaching aid is to facilitate the learning process and enhance students' understanding of mathematical concepts, particularly in the topic of proportion.

Design Stage

The next stage is Design. The design stage in the development of teaching aids aims to create a design that is valid, effective, and practical. Validation testing by experts is conducted to ensure that the design of the teaching aid is accurate, relevant to the subject matter, and suitable for the target users. This stage is crucial for identifying and correcting design issues before further development, thereby saving time and costs while ensuring the quality of the teaching aid.

At this stage, the researcher designs a teaching aid called PADI, which is used to present material on comparisons. The designed teaching aid will then be tested for its validity through assessments by experts, such as subject matter experts, teaching aid design experts, and learning experts. Outcomes of this validation will be utilized as the foundation for revising and refining the teaching aid design before proceeding to the development stage. The design image of PADI is as follows can be seen in Figure 2 below:



Figure 2. Comparison Board Design

Based on Figure 2, it shows the design of the PADI teaching aid with the following usage instructions:

1. Enter the known values from the problem into the small boxes according to the labels on the teaching aid.
2. Use "a" to represent the quantity being asked.

3. Then, enter the number 1 in the small boxes that are still empty.
4. Substitute the values into the formula.

$$O_1 \times W_1 \times H_2 = O_2 \times W_2 \times H_1 \dots\dots (5)$$

5. Calculate using formula (5).

The design that has been created will later be printed in the form of a banner and then attached to a board. The board will have a size ratio of 70 x 54 cm. The main materials used to make the teaching aid are plywood, banners, mica, and a whiteboard. In addition, the teaching aid will include usage instructions, practice questions, and quick formulas related to the topic of ratios.

Development Stage

The Development stage consists of two main activities: expert validation and field trials. The main objective of this stage is to determine the validity, practicality, and effectiveness of the PADI teaching aid.

Expert Validation

Validation was carried out by three experts: a subject matter expert, a teaching aid design expert, and a learning expert. The validation results from the subject matter expert can be seen in Table 5 below:

Table 5. Expert material validation results

No.	Aspect	Expert Score	Maximum Score
1	Competency	13	15
2	Content Material	13	15
3	Language	13	15
Quantity		39	45
Eligibility Percentage		86,66 %	
Criteria		Valid (can be used without any improvements)	

Based on Table 5, the results of the material expert validation show a score of 39 out of 45 (86.66%), which falls into the category of valid without revision. The material expert stated that the content is in accordance with the Merdeka Curriculum and can be used in Grade VII. Meanwhile, the results of the instructional media design expert validation can be seen in Table 6 below.

Table 6. Expert validation results for teaching aids

No	Aspect	Expert Score	Maximum Score
1	Design	17	20
2	Content Material	8	10
3	Language	12	15
Quantity		37	45
Feasibility Percentage		82,20%	
Criteria		Valid (can be used with minor improvements)	

Based on Table 6, the results of the expert validation of the teaching aid showed a score of 82.20%, categorized as valid and requiring minor revisions, such as changing the font to a "sans serif" type and adjusting the colors to the CMYK format

for sharper print results. The revised version of the PADI solid teaching aid can be seen as follows Figure 3.

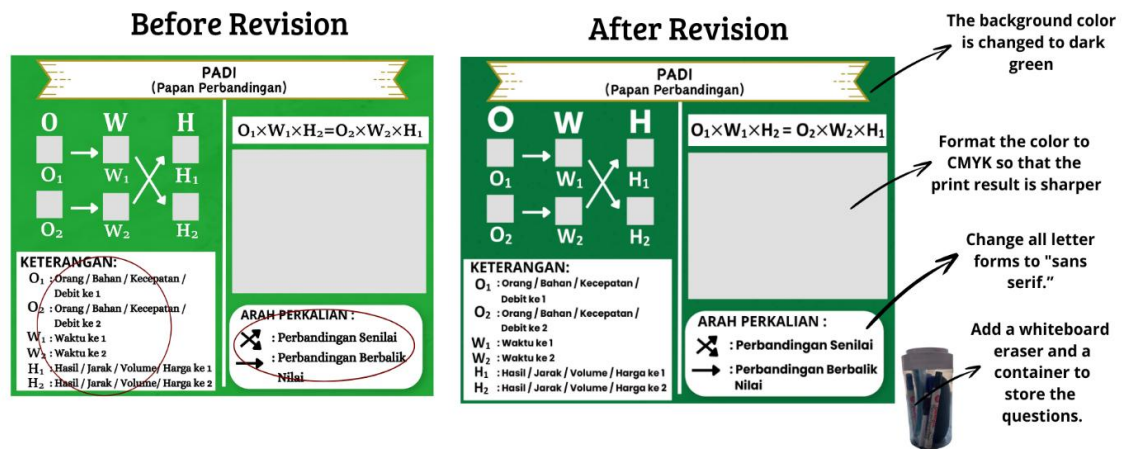


Figure 3. Design of the PADI Teaching Aid Before and After Revision

From Figure 3, a comparison is shown between the teaching aid design before and after revision, as a follow-up to input from the teaching aid design expert. The changes aim to improve the readability and visual quality of the teaching aid. These actions are expected to enhance the effectiveness of the PADI teaching aid in the learning process. The results of the validation by the learning expert can be seen in Table 7 as follows:

Table 7. Expert validation results on learning

No	Aspect	Expert Score	Maximum Score
1	Formulation of Learning Objectives	17	20
2	Content of the Teaching Module	13	15
3	Language	10	10
Quantity		40	45
Feasibility Percentage		88,88%	
Criteria		Valid (can be used without any improvements)	

Based on Table 7, the validation from the learning experts shows a percentage of 88.88%, indicating that the PADI teaching aid can be used without any revisions. The total average score from the three validators is 85.91%, which falls into the valid category.

Effectiveness Trial

The teaching aid was tested in class VIIIE of Bustanul Hikmah Islamic Junior High School with 27 students. Its effectiveness was measured through a conceptual understanding test using Quizizz with 10 questions. Figure 4 below is a bar chart showing the mastery of test results in the trial class shows in Figure 4.

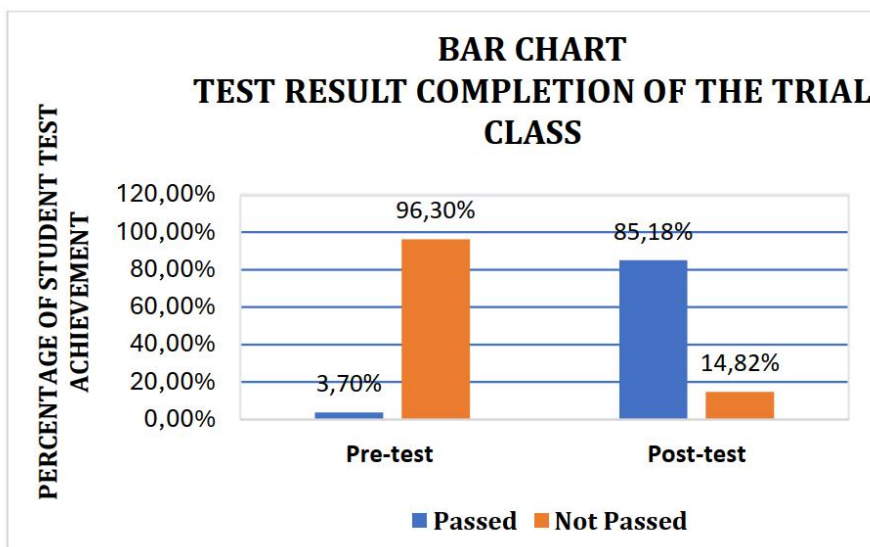


Figure 4. Bar Chart of Percentage Test for Trial Class

Based on Figure 4, the results show an increase in learning mastery from 3.70% (pre-test) to 85.18% (post-test), with 23 out of 27 students successfully exceeding the Minimum Mastery Criteria (MMC) of 78. Factors contributing to this improvement include clearer visualization of concepts, student engagement in using teaching aids, and the interactive presentation of the material.

Practicality Test

The practicality of the teaching aids was tested through a response questionnaire. The percentage results of the questionnaire from the trial class can be seen below in Table 8:

Table 8. Percentage results of the trial class questionnaire

No.	Students			Teachers		
	Score	Number of Students	Total Score	Score	Number of Teachers	Total Score
1.	10	14	140	10	1	10
2.	9	7	63			
3.	8	1	8			
4.	7	3	21			
5.	6	1	6			
6.	0	1	0			
Acquisition Score			238	10		
Maximum Score			270	10		
Practicality Percentage			88, 14%	100%		

Based on Table 8, the students scored 88.14% and the teachers scored 100%, indicating that the teaching aid is practical to use. This score suggests that both teachers and students find the teaching aid easy to use and helpful for learning.

4. Dissemination Stage

In the Disseminate stage, the researcher disseminates the PADI learning tool to class VIID. Field trials are still conducted in class VIIE. The test results in the dissemination class are presented in Table 9.

Table 9. Test results in the distribution class

No.	Type of Test	Number of Students Passed	Number of Students Not Passed
1.	<i>Pre-Test</i>	7	21
2.	<i>Post-Test</i>	24	4
Total Students			28

Based on Table 9, it shows an increase in the completeness of learning from 7 students (pre-test) to 24 students (post-test) out of a total of 28 students. This proves that the teaching aid is effective in improving students' understanding of the concepts taught. The calculation of the class response survey can be seen in Table 10 as follows:

Table 10. Results of questionnaire calculation for class distribution

No.	Students			Teachers		
	Score	Number of Students	Total Score	Score	Number of Teachers	Total Score
1.	10	9	90	10	1	10
2.	9	8	72			
3.	8	8	64			
4.	7	2	14			
5.	6	1	6			
Acquisition Score			246	10		
Maximum Score			280	10		
Practicality Percentage			87,8%	100%		

The results of this study show a practicality percentage of 87.85% from the students and 100% from the educators. This reinforces the previous trial results that the PADI teaching aid is practical and suitable for use.

This research has several advantages. The teaching aids developed are relatively easy to make as they use simple and inexpensive materials. Additionally, these teaching aids are capable of helping to improve students' understanding of concepts through a visual and interactive approach. Teachers can also directly use these teaching aids in lessons without the need for special training. However, this research also has some limitations. The trial of the teaching aids was only conducted in one school and on one subject, so further research in other schools or on other subjects is needed to ensure their effectiveness on a broader scale. Furthermore, the process of revising the design of the teaching aids requires additional time, which should be considered in their development. This research also needs to be strengthened with further studies so that the results can be used as a more solid reference.

Based on the research conducted at Bustanul Hikmah Islamic Junior High School, it is found that the PADI teaching aid for the topic of ratios is applicable within the classroom learning process. This finding aligns with studies by Hawa & Cipta (2024) and Utami et al. (2021), which show that learning media can assist both educators and students, particularly in the topic of ratios. Additionally, this study aligns with the findings of Agrestian & Nurhikmayati (2024), Suryawan & Permana (2020), Indriani et al. (2021) and Puspita et al. (2024), which state that learning media plays an essential role in improving students' understanding of mathematical concepts. This study's outcomes also reinforce the state of the art discussed in the introduction, where the need for teaching aids is still high and significantly affects the effectiveness of learning.

The theoretical contribution of this research is to provide empirical evidence that visual-based teaching aids can enhance mathematical concept understanding among junior high school students. The practical contribution is the development of teaching media that can be directly used by teachers for the topic of proportions.

Conclusion and Suggestion

This study aims to develop the PADI (Comparison Board) teaching aid that is valid, practical, and effective in improving junior high school students' conceptual understanding of ratio and proportion. The overall results of the study indicate that the PADI teaching aid meets all three criteria and can be used in the learning process. A key finding of the research shows that the PADI teaching aid is capable of visualizing the concept of comparison more concretely, thus helping students better understand the material. Therefore, this teaching aid is considered appropriate for learning medium in instructing the concept of comparison.

Educators are encouraged to use the PADI (Comparison Board) teaching aid when teaching the topic of ratio and proportion in class to help enhance students' understanding of the concept. It is expected that students will become more eager and driven while studying by utilizing this teaching aid, making it easier for them to grasp mathematical concepts, especially those related to comparison. Furthermore, future researchers are encouraged to develop this teaching aid for other topics or adapt the concept of the PADI tool to suit the learning needs at various educational levels, as well as use it as a theoretical foundation for developing other innovative learning media.

Reference

- Agrestian, R., & Nurhikmayati, I. (2024). Pengembangan Alat Peraga Valorem Fractus untuk Meningkatkan Pemahaman Konsep Siswa pada Materi Pecahan Senilai. *Papanda Journal of Mathematics and Science Research*, 3(1), 56–62. <https://doi.org/10.56916/pjmsr.v3i1.750>
- Akbar, S. (2016). *Instrumen Perangkat Pembelajaran*. Bandung: PT. Remaja Rosdakarya.
- Arikunto, S. (2019). *Prosedur Penelitian Suatu Pendekatan Praktik*. Jakarta: Rineka Cipta.
- Cahyono, B., Karoso, S., Sugito, & Baso, R. S. (2024). Implementasi Media Manipulatif untuk Pemahaman Siswa dalam Pembelajaran Matematika. *Indonesian Journal of Learning and Instructional Innovation*, 2(01), 1–6.

- <https://doi.org/10.20961/ijolii.v2i01.1303>
- Delis, I., & Wibowo, E. W. (2020). Efektivitas Penggunaan Media Manipulatif Mika Transparan Terhadap Hasil Belajar Matematika Materi Pecahan. *Ibtida'i: Jurnal Kependidikan Dasar*, 7(01), 19-36. <https://doi.org/10.32678/ibtidai.v7i01.3286>
- Fatihah, K. A. A., Kumala, E., & Dewi, M. (2024). Peran Pendidikan Dalam Perubahan Sosial Di Sekolah. *DE FACTO: Journal Of International Multidisciplinary Science*, 2(1), 52-61. <https://doi.org/10.62668/defacto.v2i1.1030>
- Gawise, G., Nurmaya, G. A. L., Jamin, M. V., & Azizah, F. N. (2022). Peranan Media Pembelajaran dalam Penguatan Pembelajaran Pendidikan Kewarganegaraan di Sekolah Dasar. *Edukatif: Jurnal Ilmu Pendidikan*, 4(3), 3575-3581. <https://doi.org/10.31004/edukatif.v4i3.2669>
- Ginanjari, A. Y. (2019). Pentingnya Penguasaan Konsep Matematika dalam Pemecahan Masalah Matematika di SD. *Jurnal Pendidikan UNIGA*, 13(1), 121-129.
- Handayani, K. T. K., Sukmawati, R. A., & Suryaningsih, Y. (2022). Pengembangan Media Pembelajaran Digital pada Materi Perbandingan untuk Siswa Kelas VII. *Computing and Education Tecnologi Journal (CEJT)*, 2, 1-9.
- Hawa, M. N. AL, & Cipta, D. A. S. (2024). Pengembangan Media Pembelajaran Commath dalam Problem Based Learning untuk Pemahaman Siswa pada Materi Perbandingan. *Mathema Journal*, 6(2), 585-602. <https://doi.org/10.33365/jm.v6i2.4172>
- Indriani, W., Nufus, H., & Wulandari, W. (2021). Pengembangan Alat Peraga Papan Turunan Matematika untuk Meningkatkan Pemahaman Konsep Matematis Siswa SMA Negeri 4 Kejuruan Muda. *Jurnal Pendidikan Matematika Malikussaleh*, 1(2), 124. <https://doi.org/10.29103/jpmm.v1i2.6498>
- Intan, N. A. R., & Mampouw, H. L. (2021). Pengembangan E-Modul Berani Berbasis Android pada Materi Perbandingan Berbalik Nilai. *JNPM (Jurnal Nasional Pendidikan Matematika)*, 5(2), 374. <https://doi.org/10.33603/jnpm.v5i2.4938>
- Izzabella, S. E., & Amin, S. M. (2021). Penerapan Pendekatan PMRI pada Materi Perbandingan di Kelas VIII SMP. *Jurnal Ilmiah Pendidikan Matematika*, 10(1), 45-58.
- Jonimar, J. (2020). Pemanfaatan Alat Peraga IPA Untuk Meningkatkan Kemampuan Guru dan Hasil Belajar Siswa Sekolah Dasar. *ISEJ: Indonesian Science Education Journal*, 1(2), 69-84.
- Khoiruddin, M., Vahlia, I., & ES, Y. R. (2024). Analisis Pemahaman Konsep Peserta Didik Ditinjau dari Kemampuan Metakognisi Peserta Didik Pada Materi Bilangan Pecahan. *Emteka: Jurnal Pendidikan Matematika*, 5(2), 522-530. <https://doi.org/10.24127/emteka.v5i2.5808>
- Ningrum, P. A., & Rohim, A. (2023). Peranan Pengembangan E-Modul Interaktif Berbasis Canva dengan Pendekatan PMRI untuk Meningkatkan Kemampuan Pemecahan Masalah Siswa. *Wahana Pedagogika: Jurnal Ilmiah Pendidikan Dan Pembelajaran*, 5(2), 41-50. <https://doi.org/10.52166/wp.v5i02.5629>
- Nurfadhillah, S., Ningsih, D. A., Ramadhania, P. R., & Sifa, U. N. (2021). Peranan Media Pembelajaran dalam Meningkatkan Minat Belajar Siswa SD Negeri Kohod III. *PENSA: Jurnal Pendidikan dan Ilmu Sosial*, 3(2), 243-255.

<https://ejournal.stitpn.ac.id/index.php/pensa/article/view/1338>

- Puspita, D., Efriani, A., & Afgani, M. W. (2024). Pengembangan Media Pembelajaran Geogebra untuk Meningkatkan Pemahaman Konsep Bangun Ruang Sisi Datar pada Siswa Sekolah Menengah Pertama (SMP). *De Fermat: Jurnal Pendidikan Matematika*, 7(1), 11–21. <https://doi.org/10.36277/deferemat.v7i1.326>
- Rohim, A. (2015). Efektivitas Penggunaan Media Kubus Guling Berwarna (Meku-Guwa) dalam Menemukan Pola Jaring-Jaring Kubus. *INSPIRAMATIKA: Jurnal Inovasi Pendidikan dan Pembelajaran Matematika*, 1–8.
- Rohim, A., & Asmana, A. T. (2023). Pengembangan Media ROKA'AT (roda Akar Dan Pangkat) Untuk Meningkatkan Kemampuan Reversible Thinking Matematis Siswa. *Majamath: Jurnal Matematika dan Pendidikan Matematika*, 6(2), 111–123.
- Sari, D. P., Nurochmah, N., Haryadi, H., & Syaiturjim, S. (2016). Meningkatkan Kemampuan Pemahaman Matematis Melalui Pendekatan Pembelajaran Student Teams Achivement Division. *Jurnal Riset Pendidikan Matematika*, 3(1), 16–22. <https://doi.org/10.21831/jrpm.v3i1.7547>
- Sari, N. M. (2020). Analisis Kesulitan Siswa dalam Mengerjakan Soal Matematika Materi Perbandingan Kelas VII SMP Luhur Baladika. *Jurnal Equation: Teori Dan Penelitian Pendidikan Matematika*, 3(1), 22–33.
- Sudarman, S. W., & Vahlia, I. (2018). Efektifitas Penggunaan Metode Pembelajaran Quantum Learning Terhadap Kemampuan Pemahaman Konsep Matematis Mahasiswa. *Al-Jabar: Jurnal Pendidikan Matematika*, 7(2), 275–282. <https://doi.org/10.24042/ajpm.v7i2.42>
- Sugiyono. (2021). *Metode Penelitian Kuantitatif Kualiatatif dan R&D* (2nd ed.). Bandung: Alfabeta.
- Suhartatik, T. (2020). *Best Practice Implikasi Media Quizizz Berbasis Android terhadap Kualitas Pembelajaran dalam Mencetak Siswa Berprestasi di Tingkat Nasional*. Ahlimedia Book.
- Suryawan, I. P. P., & Permana, D. (2020). Media Pembelajaran Online Berbasis Geogebra sebagai Upaya Meningkatkan Pemahaman Konsep Matematika. *Prisma*, 9(1), 108–117. <https://doi.org/10.35194/jp.v9i1.929>
- Telaumbanua, Y. (2020). Efektifitas Penggunaan Alat Peraga Pada Pembelajaran Matematika pada Sekolah Dasar Pokok Bahasan Pecahan. *Warta Dharmawangsa*, 14(4), 709–722. <https://doi.org/10.46576/wdw.v14i4.900>
- Trianto. (2017). *Mendesai Model Pembelajaran Inovatif Progesif dan Kontekstual*. Jakarta: Prenada Media Group.
- Utami, A. J. L., Rafiq, Z., & Imami, A. I. (2021). Pengembangan Komik Matematika untuk Materi Perbandingan Senilai dan Berbalik Nilai. *Jurnal Ilmiah Pendidikan Matematika*, 6(1), 124–136. <https://doi.org/10.26877/jipmat.v6i1.7044>
- Utami, K. (2023). *Pengembangan Media Pembelajaran Roda Pintar pada Materi Perbandingan untuk Meningkatkan Kemampuan Penalaran Proporsional Siswa Kelas VII di SMP Argopuro 1 Panti Jember* (UIN Kiai Haji Achmad Siddiq Jember). UIN Kiai Haji Achmad Siddiq Jember.