

## Development of the Logarithm Exponent Root Calculation Board (PAPA LAPAR) to Optimize More Interactive Learning

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### Abstract

Mathematics learning is often perceived as difficult by students, particularly in abstract topics such as logarithms, exponents, and roots. This study developed a teaching aid-based learning medium called PAPA LAPAR (Logarithm, Exponent, and Root Calculation Board) using the Research and Development (R&D) method with the ADDIE model, consisting of the stages of analysis, design, development, implementation, and evaluation. Data were collected using expert validation sheets to assess media feasibility, student response questionnaires to measure practicality, and pre-test and post-test learning outcome assessments to determine effectiveness. Data analysis was conducted by calculating the mean validation scores to determine validity, the percentage of student responses to determine practicality, and the improvement of scores and learning mastery to determine effectiveness. The results indicate that the media achieved a very high level of validity (mean score 87.67), very good practicality (student response score 90), and effectiveness in improving learning outcomes, shown by an increase in the average score from 65 to 85 with a mastery level of 85%. Therefore, PAPA LAPAR is proven to be valid, practical, and effective as a mathematics learning medium and supports more concrete, active, and meaningful learning.

### Keywords

*ADDIE Model, Interactive Learning, Logarithm Concepts, Media Validity, PAPA LAPAR.*

### Introduction

Mathematics is a subject taught at every level of education and plays an essential role in supporting the mastery of various other fields of knowledge. Nevertheless, many students still struggle to understand mathematical concepts and often obtain low achievement. Appropriate strategies are therefore needed to address the factors that hinder optimal learning outcomes (Ningrum and Rohim, [2023](#)). The success of mathematics learning is strongly influenced by students' foundational understanding, their learning preferences, and the teaching models, methods, and learning materials used by teachers (Aulia et al., [2023](#)). Therefore, improving the quality of mathematics learning requires well designed instructional approaches that align with students' characteristics and learning needs.

Mathematics learning frequently becomes a major challenge in education. Numerous studies indicate that students experience difficulties when dealing with abstract ideas such as roots, exponents, and logarithms, partly due to the limited availability of concrete and interactive learning tools (Ginanjar, [2019](#)). Such difficulties often result in low motivation and limited interest in learning mathematics, which ultimately affect students' performance (Priyanti and Nurhayati, [2023](#)). To overcome these challenges, innovative learning media are needed to bridge the gap between abstract theory and practical understanding while simultaneously offering more meaningful learning experiences that respond to increasing educational demands.

Instructional media in mathematics learning have been shown to significantly enhance conceptual understanding and student engagement. Darmayanti ([2023](#)) reported that visual and manipulative media help students connect abstract concepts with concrete experiences, thus facilitating the learning process. This aligns with the constructivist perspective, which emphasizes the importance of direct experience in shaping knowledge (Ginting, [2018](#)). The findings of Ilmiyah et al. ([2024](#)) also demonstrate significant pre–post learning improvements after the use of visual media. When learning is supported by manipulatives, students participate more actively rather than passively receiving information, which in turn strengthens their motivation and interest in mathematics.

Furthermore, Badri and Azisi ([2024](#)) found that well-designed manipulatives enhance student interaction, encouraging discussion and collaboration in problem solving. These interactions enrich the learning experience and foster social and communication skills essential for students' academic development. In this context, instructional tools such as PAPA LAPAR not only serve as media for delivering content but also support the creation of collaborative and dynamic learning environments. Rohim et al. ([2021](#)) reported that the Roka'at media provided valuable learning experiences for teachers in understanding operations involving roots and exponents.

The use of manipulatives is also beneficial in reducing mathematics anxiety, especially among students who feel overwhelmed by abstract and complex concepts. Through interactive tools, these concepts can be more easily understood and applied to real-world situations (Lazuarni et al., [2024](#); Rohim et al., [2014](#)). Rahayu et al. ([2017](#)) found that students who used manipulatives reported higher confidence and interest in mathematics. Rohim et al. ([2024](#)) also highlighted that media-assisted learning supports students in solving mathematical problems more effectively. Thus, beyond improving conceptual

understanding, manipulatives also contribute to cultivating positive attitudes toward mathematics learning.

One of the innovations developed to support mathematics learning is PAPA LAPAR (Logarithm Exponent Root Calculation Board). This medium is designed to help students understand mathematical operations such as logarithms, exponents, and roots through a visual and interactive approach. Functioning as a practical manipulative, PAPA LAPAR enables students to explore challenging mathematical ideas through clear visualizations and hands-on activities (Ariska et al., [2022](#)). By incorporating engaging designs aligned with modern educational needs, this learning tool aims to increase student enthusiasm and involvement. The demand for learning media that not only support conceptual comprehension but also stimulate interaction and independent learning strengthens the urgency for developing such tools in current mathematics instruction.

The development of innovative learning media is crucial, as students today must not only understand theoretical concepts but also be able to apply them in real-world situations (Ery, [2023](#)). PAPA LAPAR offers an innovative approach that bridges the gap between theory and practice. Its novelty lies in the integrated visualization of logarithmic, exponential, and radical operations within a single, unified manipulative tool—an instructional design that remains limited in previous studies. This unique combination provides students with a more comprehensive and meaningful learning experience. This study therefore aims to design, develop, and evaluate the effectiveness of PAPA LAPAR in mathematics learning. The main focus is to examine how this medium enhances students' understanding of logarithms, exponents, and roots, as well as its influence on their learning motivation. The urgency of this research is further reinforced by the growing need in schools for concrete learning media that can assist students in comprehending abstract and challenging mathematical content. The findings of this study are expected to contribute to the development of more engaging and effective mathematical learning resources.

## Methods

To develop the learning material, this study employed a Research and Development (R&D) methodology using the ADDIE PAPA LAPAR development framework. This approach aims to produce educational materials that are useful, highly valid, and proven effective in supporting the mathematics learning process, particularly in topics involving logarithms, exponents, and roots. The development procedure follows the five main stages of the ADDIE

model—analysis, design, development, implementation, and evaluation—as described by Branch (2009). This research consisted of five stages in total, which are illustrated in detail in [Figure 1](#).

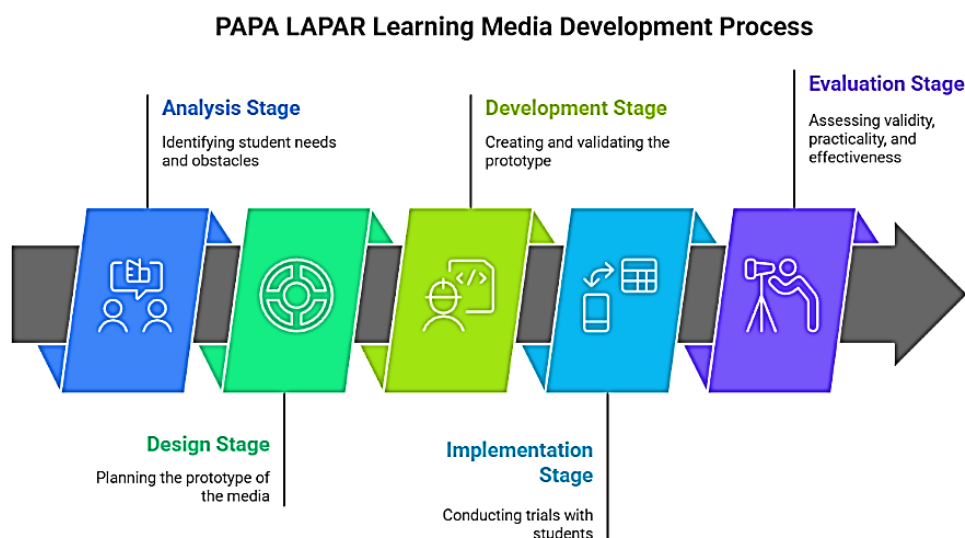


Figure 1. Research steps based on the ADDIE R&D design

## Results and Discussion

The purpose of this study was to develop an interactive instructional material, PAPA LAPAR, as an effort to enhance students' understanding of logarithm, exponent, and root concepts. The research followed several stages described below:

### a. Analysis

Based on surveys and interviews with teachers and students, it was found that the current learning approach tends to be less interactive and has not been able to stimulate students' learning interest. Many students reported feeling bored and less engaged during lessons. These findings indicate the need for a more attractive and interactive learning medium, such as an educational tool that can better support students' motivation and participation.

### b. Design

In the design stage, PAPA LAPAR was conceptualized as an educational tool that integrates learning content with enjoyable interactive activities. Several key features were included, such as interactive quizzes, group challenge activities, and real-time feedback. An initial prototype was tested with a group of students to obtain feedback regarding the interface, content accuracy, and level of difficulty.

### c. Development

Following feedback from the initial trial, revisions were made to both the content and interface. The development phase involved subject-matter experts and graphic designers to ensure the quality and relevance of the material. The final version of PAPA LAPAR was then tested in several classes, with its effectiveness measured through pretests and posttests.

The development process began with the design of the PAPA LAPAR media. The tool was designed in a rectangular form with movable sliding components, each color representing different values. The use of color coding was intended to help students insert numbers into the correct colored columns and obtain accurate results. The design was created as follows:

Figure 2. PAPA LAPAR Media Design

PAPA LAPAR was produced using practical and durable materials to ensure ease of use in the classroom. Acrylic was chosen for its lightweight, sturdy, and long lasting properties. Media validation was conducted by a media expert (a university lecturer specializing in instructional media) and a practitioner (a senior high school mathematics teacher) to ensure its suitability for instructional use. Based on the validation results, PAPA LAPAR met the required criteria in terms of content appropriateness, design, and functionality. Several revisions were made following expert feedback to improve the final media product. The completed media is shown in the [Figure 2](#).

The validation results assessed three major aspects: content feasibility, media design, and functional usefulness.

Table 1. Validation Results

Aspect	Maximum Score	Score Obtained	Category
Design and appearance	1	0.90	Highly Valid
Quality and durability	1	0.85	Highly Valid
Content relevance and effectiveness	1	0.88	Valid
<b>Average</b>	<b>1</b>	<b>0.87</b>	<b>Highly Valid</b>

The validation results show that the PAPA LAPAR mathematics instructional media is categorized as highly valid and suitable for use in educational settings. In terms of design and appearance, it scored 0.90 out of 1, indicating that the media is visually appealing, easy to read, and structured to support student comprehension. For quality and durability, it received a high score of 0.85, suggesting that the materials used are strong and appropriate for repeated classroom use.

Meanwhile, the aspect of content relevance and effectiveness obtained a score of 0.88, placing it in the Valid category, meaning that the instructional content aligns well with the curriculum and effectively supports concept understanding, although some refinement is still possible. Overall, the media achieved a total score of 87.67 out of 100, placing it in the Highly Valid category, demonstrating that PAPA LAPAR is an effective, highquality learning medium suitable for integration into mathematics instruction, particularly in teaching logarithm, exponent, and root concepts.

#### d. Implementation

The implementation of the PAPA LAPAR media involved several schools, with participants from different grade levels contributing to the learning activities. To measure students' engagement during the learning process, classroom observations were conducted. The results indicated that the use of PAPA LAPAR supported an effective learning environment, as shown by the high level of participation and interaction among students throughout the activities.

The following findings summarize the results obtained from the pilot test conducted with senior high school students.

Table 2. Practicality Results

Aspect	Score	Category
Interest and Comfort	0.90	Very Practical
Conceptual Understanding	0.83	Practical
Interaction and Participation	0.83	Practical
Motivation and Recommendation	0.81	Practical
Content Appropriateness	0.86	Practical
<b>Average</b>	<b>0.84</b>	<b>Practical</b>

Based on the practicality assessment, the PAPA LAPAR media obtained an average score of 0.84, classified as Practical. The highest score was found in the Interest and Comfort aspect at 0.90 (Very Practical), indicating that the media successfully captured students' attention

and provided a comfortable learning experience. Other aspects, including Conceptual Understanding, Interaction and Participation, Motivation and Recommendation, and Content Appropriateness, scored between 0.81 and 0.86, falling within the Practical category.

These results demonstrate that PAPA LAPAR effectively supports mathematics learning. The high scores in Conceptual Understanding and Content Appropriateness show that the media aligns well with learning objectives and enhances students' comprehension of the material. Likewise, the positive scores in Interaction, Participation, and Motivation indicate that the media encourages active engagement and is well-recommended as a learning tool. Overall, PAPA LAPAR meets the criteria for practicality and is considered suitable for classroom implementation.

Table 3. Effectiveness Results

Indicator	Pre-Test	Post-Test	Improvement
Average Student Score	52	82	57.69%
Percentage of Students Meeting Mastery Criteria	40%	93%	132.5%
Learning Motivation Level (Scale of 5)	3.1	4.6	48.39%

The use of PAPA LAPAR in mathematics instruction demonstrated strong effectiveness. Students' learning outcomes improved significantly, as shown by the 57.69% increase in the average score and the rise in mastery completion from 40% to 93%, representing an improvement of 132.5%. Students' motivation scores also increased from 3.1 to 4.6 on a five-point scale, equivalent to a 48.39% improvement. These results indicate that the PAPA LAPAR media is capable of enhancing academic achievement while also fostering students' enthusiasm and interest in learning.

PAPA LAPAR offers a visually engaging approach through the use of colors, symbols, and an interactive board format, strengthening students' cognitive processing. Its creative and mnemonic design provides an additional advantage, making the material easier to recall. Teachers also responded positively to its implementation, and students expressed that the learning experience felt more engaging and less monotonous. Therefore, PAPA LAPAR can be characterized as an effective, innovative, and inclusive learning medium that contributes to a more meaningful and comprehensive learning environment.

## e. Evaluation

Students' motivation and interest in learning are critical components that influence the success of the instructional process. In the context of using the PAPA LAPAR learning media, increases in students' motivation and engagement were evident through several indicators:

### 1. Active Engagement in Learning

Students demonstrated strong enthusiasm when using the PAPA LAPAR media. This tool enables learners to directly manipulate its components, allowing them to engage more deeply with logarithm, exponent, and root concepts. The interactive approach encouraged students to ask questions and participate in discussions, ultimately enhancing their involvement in the learning process.

### 2. Improved Self Confidence

Because the media is designed to be easy to understand, students felt more confident when studying material previously considered difficult. The learning process became more enjoyable as abstract concepts such as logarithms were presented in a more concrete and accessible form.

### 3. Positive Attitude Toward Learning Media

Most students expressed that the design of PAPA LAPAR was attractive and innovative. The use of colors and the interactive structure contributed to a more conducive and enjoyable learning atmosphere, increasing their interest in continuing to learn with the media.

### 4. Encouragement for Independent Learning

The media provided opportunities for students to explore the material independently. With minimal guidance from the teacher, they were able to study autonomously and deepen their mathematical understanding. This fostered curiosity and promoted positive study habits.

### 5. Memorable Learning Experiences

The use of PAPA LAPAR created memorable learning experiences. The use of concrete materials helped students recall the concepts more effectively. Students also felt that this method differed from conventional instruction, increasing their overall interest in mathematics.

Findings from the development of the PAPA LAPAR interactive media show significant positive effects on students' understanding and enthusiasm for learning. These outcomes align with previous studies emphasizing the value of interactive learning tools. Research by Wulandari ([2020](#)) reported that interactive media positively influences students' active engagement and improves learning outcomes in mathematics. The study highlighted that students' conceptual understanding increased more substantially when using interactive tools compared to traditional methods. Similarly, Jannah et al. ([2024](#)) found that interactive media enhances students' motivation and comprehension in trigonometry. This is consistent with the present study, where the average student score increased from 52 to 82 after using PAPA LAPAR, and the percentage of students achieving mastery rose from 40 percent to 93 percent.

The development of this media illustrates that well structured instructional materials can help students understand challenging ideas such as logarithms, exponents, and roots in more creative and engaging ways (Rohmah et al., [2024](#)). Research by Abdullah et al. ([2024](#)) supports this, noting that interactive media has strong potential to boost students' learning motivation, as reflected in student satisfaction scores reaching 85 percent. PAPA LAPAR successfully created a lively learning environment and fostered student participation.

Students' active participation, demonstrated through their enthusiasm in using the interactive tool, is aligned with constructivist theory, which states that active involvement enhances learning (Nastiti and Wathon, [2019](#)). PAPA LAPAR not only allows students to manipulate components but also encourages them to communicate and ask questions, contributing to greater participation (Asyikin, [2021](#)).

Moreover, increased student self confidence in learning previously difficult content indicates that the media succeeded in changing students' perceptions of mathematics. Studies by Putri and Fitriyani ([2024](#)) and Rohim ([2014](#)) affirm that visually appealing instructional materials can help reduce fear and anxiety toward mathematics. Thus, PAPA LAPAR serves not only as a learning tool but also as a means for creating engaging and memorable learning experiences.

The PAPA LAPAR media has been shown to significantly improve students' motivation, interest, and learning outcomes. Its ease of use and visual interactive approach make it highly beneficial, particularly for abstract mathematical content (Agustina et al., [2024](#); Apriani, [2018](#)). Students using PAPA LAPAR experienced not only an improvement in conceptual understanding but also increased enthusiasm throughout the learning process. This is

consistent with earlier findings showing that interactive learning tools can reduce students' anxiety about difficult topics and strengthen their confidence (Rohim et al., [2024](#)).

With further refinement and adaptation, PAPA LAPAR has the potential for wider use in senior high schools. Adjustments to content and difficulty levels can be made to meet the needs of different student groups, enabling implementation in classes with diverse abilities. Furthermore, integrating technology, such as mobile applications or online platforms, can expand access to PAPA LAPAR and allow students to continue their learning independently outside the classroom. Considering the rapid advancement of technology and the need for flexible and adaptive learning experiences, this direction is increasingly important (Permana et al., [2024](#)). Therefore, continuous development and technological integration are essential to maximize the sustainability and broader impact of PAPA LAPAR in mathematics education.

Additionally, the use of PAPA LAPAR can promote student collaboration, allowing learners to work in groups to complete tasks or challenges. This interaction enriches the learning experience and helps students develop essential social and communication skills needed in modern workplaces (Andriono, [2021](#)). Thus, PAPA LAPAR functions not only as a learning aid but also as a tool for fostering character development and interpersonal competence (Jannah et al., [2024](#)). Therefore, its implementation supports both cognitive achievement and the development of essential soft skills in learning.

Overall, the findings of this study support the claim that developing interactive educational media such as PAPA LAPAR can produce a significant positive impact on students' understanding, motivation, and interest in learning. This research is expected to serve as a reference for future media development and encourage educators to integrate technology and innovative instructional methods into teaching practices.

## Conclusion and Recommendations

Based on the findings of this study, the PAPA LAPAR learning tool (Logarithm Exponent Root Calculation Board) has demonstrated reliability, usefulness, and efficiency in supporting mathematics learning, particularly on logarithms, exponents, and roots. The validity of this media was confirmed through expert evaluations covering design, quality, and content alignment, resulting in an average score of 87.67, which falls into the highly valid category. Its practicality score reached an average of 0.84, indicating that PAPA LAPAR is

easy to use, engaging, and capable of increasing students' involvement in the learning process. A significant improvement in student learning outcomes, shown by an increase in the average score from 52 to 82, a rise in mastery percentage from 40 percent to 93 percent, and an improvement in learning motivation by 48.39 percent, further supports the effectiveness of this instructional tool. Through its visual and interactive approach, PAPA LAPAR not only simplifies abstract concepts but also creates enjoyable and meaningful learning experiences for students.

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