



# JAPERU: Board Game-Based Learning Media to Improve Seventh Grade Students' Understanding of Distance and Displacement at SMPN 232 Jakarta

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## ABSTRACT

This study aims to develop and validate JAPERU, a board game-based learning media designed to improve seventh-grade students' understanding of distance and displacement concepts at SMPN 232 Jakarta. The research employed a Research and Development (R&D) method using the ADDIE model. Expert validation results showed a feasibility score of 91.75%, categorized as highly suitable. The effectiveness of the media was tested through small- and large-scale trials using a one-group pre-test and post-test design. The results indicated consistent improvement in students' scores with a moderate N-gain (0.56). Student responses were categorized as very good, reflecting high engagement and positive perceptions. These findings suggest that JAPERU is a feasible and effective instructional media for enhancing conceptual understanding in junior high school physics learning.

## ABSTRAK (STYLE 'HEADING 1')

Penelitian ini bertujuan untuk mengembangkan dan memvalidasi JAPERU, media pembelajaran berbasis permainan papan yang dirancang untuk meningkatkan pemahaman konsep jarak dan perpindahan siswa kelas tujuh di SMPN 232 Jakarta. Penelitian ini menggunakan metode Penelitian dan Pengembangan (R&D) dengan model ADDIE. Hasil validasi ahli menunjukkan skor kelayakan sebesar 91,75%, yang dikategorikan sangat sesuai. Efektivitas media diuji melalui uji coba skala kecil dan besar menggunakan desain pre-test dan post-test satu kelompok. Hasil menunjukkan peningkatan yang konsisten pada skor siswa dengan N-gain sedang (0,56). Respons siswa dikategorikan sangat baik, mencerminkan keterlibatan yang tinggi dan persepsi positif. Temuan ini menunjukkan bahwa JAPERU merupakan media pembelajaran yang layak dan efektif untuk meningkatkan pemahaman konseptual dalam pembelajaran fisika SMP.

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## INTRODUCTION

Formal education is structured through a curriculum that includes various subjects and core materials, one of which is physics. As a branch of Natural Sciences (IPA), physics is positioned as a fundamental subject because it teaches students to think logically, critically, and systematically. Therefore, physics is not simply a collection of facts, concepts, and principles, but also encompasses the process of discovery through a scientific approach. Physics learning is designed to help students understand various natural phenomena while developing critical and logical thinking skills in addressing real-world problems. Ideally, this learning process involves experiments, discussions, and problem-solving so that students not only understand the concepts but also apply them contextually (Ardianti et al., 2025). Therefore, physics learning plays an essential role in fostering students' conceptual understanding and higher-order thinking skills.

However, it is acknowledged that junior high school students often encounter various challenges when learning physics concepts (Shreshta et al., 2023). These challenges are influenced by students' daily experiences, including their prior learning experiences, as well as physics instruction that often presents abstract concepts (Klein et al., 2019; Ate et al., 2025). These difficulties are further exacerbated by instructional approaches that are less contextual (Septipriyani et al., 2025) and the limited use of engaging learning media (Taufik et al., 2023). As a result, students' interest in learning decreases, leading to unsatisfactory learning outcomes. This condition indicates the need for more contextual and engaging instructional strategies to support effective physics learning.

Physics contains many abstract concepts that require appropriate instructional tools capable of transforming abstract ideas into more concrete representations to facilitate understanding. One example can be found in the topic of motion, particularly the concepts of distance and displacement. Many students assume that distance and displacement are identical concepts. Although some students recognize that the two are different, they often lack a clear conceptual understanding of their distinctions (Yolanda, 2017). This misconception highlights the importance of using appropriate learning media to help students differentiate and understand motion concepts more effectively. Learning media plays an important role in increasing the effectiveness of the teaching and learning process. According to Sadiman et al. (2010), the use of media can stimulate students' thoughts, feelings, attention, and interests so that the learning process can occur optimally. Learning media also functions as a tool for teachers to convey information to students through interesting stimuli, making it easier for students to understand the material presented. One form of effective learning media is game-based media. Prasetyo and Wijaya (2019) stated that game-based media has several advantages, including: (1) games are fun and entertaining, (2) involve student activity directly, (3) provide direct feedback to both teachers and students, (4) allow students to apply concepts in problem solving, (5) are flexible, and (6) are easy to create and can be reproduced.

The results of a needs analysis conducted among seventh-grade students at SMPN 232 Jakarta support this potential. Out of 154 respondents, 86 students indicated that game-based learning media best supported their understanding of science material. Additionally, 90 students identified the topic "Motion and Force," particularly the subtopic "Distance and Displacement," as suitable for delivery through game-based media.

Interviews with several junior high school science teachers were carried out. It is revealed that students frequently have misconceptions, particularly regarding distance and displacement. Teachers believe interactive game-based learning media are needed to support students' understanding of the material. These findings align with previous research, which found that enhancing students' understanding of physics, particularly distance and displacement, requires learning media that can enhance learning motivation and present abstract concepts in a more concrete and understandable way.

Although previous studies have explored the use of digital games and interactive multimedia in physics learning (e.g., Prasetyo & Wijaya, 2019; Taufik et al., 2023), limited research has specifically developed and validated board game-based learning media focusing on distance and displacement concepts at the junior high school level. Moreover, existing studies tend to emphasize digital platforms, while non-digital board games that promote direct social interaction and collaborative learning remain underexplored (Sidarta & Yuniarta, 2019).

Based on these considerations, this study aims to develop and validate a board game-based learning media called JAPERU (Jarak Perpindahan Seru). The media is designed to support seventh-grade students at SMPN 232 Jakarta in understanding the concepts of distance and displacement in a more interactive, engaging, and meaningful manner. It is expected that the implementation of JAPERU will enhance students' conceptual understanding and improve the quality of the learning process.

## METHODS

This study employed a research and development (R&D) design using the ADDIE model, which consists of five stages: Analyze, Design, Develop, Implement, and Evaluate. The ADDIE model is commonly used structured approach to developing instructional materials. The purpose of this model is to produce learning design and produce learning materials for more effective and efficient teaching (Adeoye et al., 2024). The ADDIE model can be applied to develop various types of products in learning activities, including learning strategies, methods, instructional methods, media, and teaching materials (Adriani et al., 2019). This model was considered appropriate for developing JAPERU (Jarak Perpindahan Seru), a board game-based learning media designed to enhance students' understanding of distance and displacement concepts.

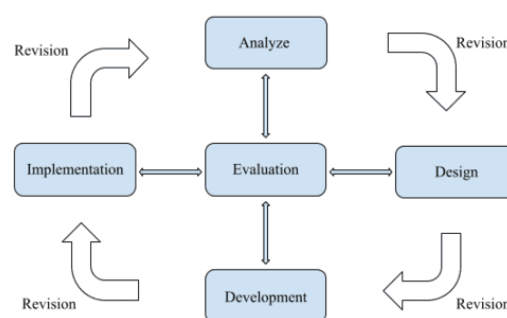


Figure 1. The procedure of ADDIE  
Source: Adeoye et al. (2024)

**1. Analyze**

The analyze stage was conducted to identify students' learning needs and existing challenges in understanding physics concepts, particularly distance and displacement. A needs analysis questionnaire was distributed to seventh-grade students at SMPN 232 Jakarta and SMPN 1 Cikarang Selatan. The questionnaire aimed to identify students' preferred learning media, the topics they found most difficult, and the types of instructional approaches they experienced in class. In addition, interviews were conducted with science teachers to gather insights into common student misconceptions and the availability of learning media in school. The results of this stage served as the basis for determining the type of media to be developed and the content to be addressed.

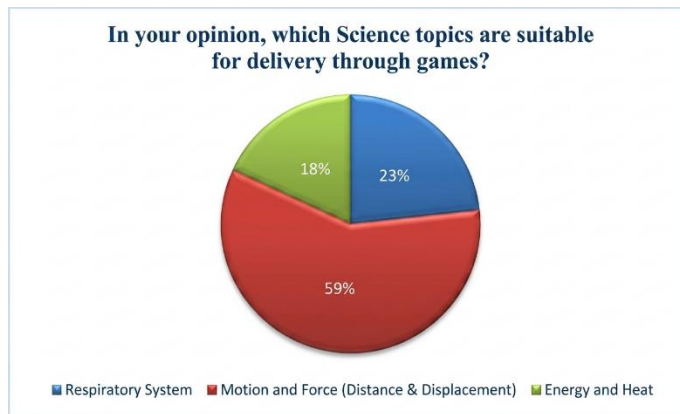


Figure 2. Needs analysis result

**2. Design**

The design stage involved planning the structure and components of the JAPERU board game. The activities included:

- a. Formulating learning objectives based on the Grade Seven curriculum.
- b. Developing learning materials related to distance and displacement concepts.
- c. Designing game components, including the board layout, question cards, pawns, rules of the game, and scoring system.
- d. Determining visual elements such as colors, illustrations, and typography to enhance student engagement and readability.

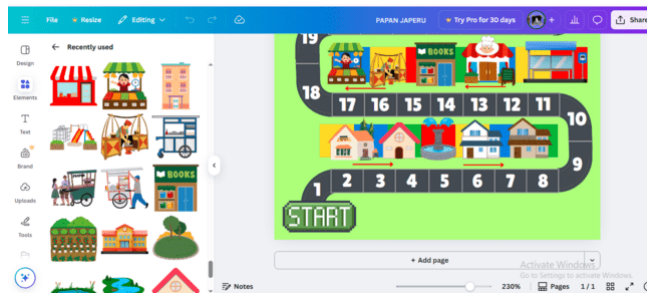


Figure 3. Design process of JAPERU game-board

**3. Development**

During the development stage, the JAPERU prototype was produced based on the prepared design. The game board, question cards, pawns, and supporting materials were developed accordingly. The product was then validated by material experts and media experts to evaluate content accuracy, conceptual suitability, instructional quality, visual design, readability, and usability. The validation data were analyzed using a percentage formula as follows:

$$Percentage: \frac{Obtained\ Score}{Maximum\ Score} \times 100\%$$

The resulting percentage scores were then interpreted based on predetermined feasibility criteria, where a score of 81–100% was categorized as very suitable. Suggestions and feedback from the validators were used to revise and refine the product until it met the established feasibility standards and was considered appropriate for classroom implementation.

#### 4. Implementation

The implementation stage involved conducting small-scale and large-scale trials with seventh-grade students. A one-group pre-test and post-test design was used to measure students' conceptual understanding before and after using the developed JAPERU media.

Students were given a pre-test prior to the learning activity and a post-test after the implementation.

To determine the effectiveness of the media in improving conceptual understanding, the normalized gain (N-gain) was calculated using the following formula:

$$g = \frac{(post - pre)}{(max\ score - pre)}$$

The interpretation of the N-gain score followed the criteria proposed by Hake (1998), in which  $g \geq 0.7$  is categorized as high,  $0.3 \leq g < 0.7$  as medium (moderate), and  $g < 0.3$  as low. In addition to test results, observations and response questionnaires were administered to collect feedback from students and teachers regarding the practicality and engagement level of the developed learning media

#### 5. Evaluation

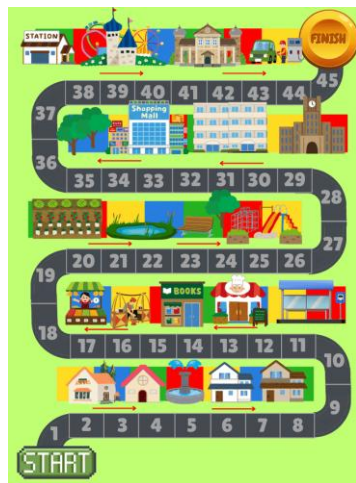
The evaluation stage was conducted to determine the feasibility and effectiveness of the JAPERU learning media. The evaluation was based on: (1) Expert validation results, (2) Students' pre-test and post-test scores, (3) Student response questionnaires, and (4) Teacher's feedback. The data were analyzed to assess improvements in conceptual understanding and to determine whether the developed media met the criteria for instructional use.

### RESULTS AND DISCUSSIONS

#### Result

##### 1. Analyze

The needs analysis revealed that the majority of students experienced difficulties in understanding the concepts of distance and displacement, particularly when taught through conventional lecture-based methods. Furthermore, 58.4% of students considered motion and force material, particularly distance and displacement, suitable to be delivered through games. Meanwhile, 49.4% reported that the topic was difficult to understand when explained only through lectures. These findings confirmed the need for engaging and interactive learning media to support conceptual understanding in physics.



a) JAPERU board game



b) Question Card



c) Car-shaped pawns



d) A dice

Figure 4. JAPERU board game essentials

## 2. Design

The design stage resulted in the development of all structural components of the JAPERU board game. The game board features numbered pathways that guide players through challenges and activities related to distance and displacement concepts. Players advance along the board by rolling dice, landing on spaces that direct them to answer conceptual questions or complete short tasks. Question cards are categorized according to conceptual indicators aligned with the Grade VII physics curriculum, covering definitional, computational, and contextual aspects of distance and displacement. The pawns are designed in the shape of cars to reinforce the motion theme and increase students' interest. A guidebook was also prepared to assist both teachers and students in understanding the rules and objectives of the game. The overall visual design, including color choices, typography, and layout, was developed to be age-appropriate, visually appealing, and cognitively accessible for seventh-grade learners.

## 3. Development

### a. Design and Media Validation

This research went through a four-stage validation process involving media experts and material experts from the Physics Education Study Program. Validation was conducted to assess the feasibility of the design and content of the developed product. The validation process used a questionnaire administered to each validator. Validation covered material aspects, including the suitability of the content to learning objectives, conceptual accuracy, and depth of the material, as well as media aspects, including appearance, design, readability, and ease of use. The validation results were used to revise and refine the product to ensure it was suitable for use in learning activities. The validation results from media and material experts are presented in Table 1.

Table 1. Expert Test Result

Expert Test		Obtained Score	Expected Score	Achievement Percentage	Description
Media Expert Validation	Expert 1	4.85	5.0	97%	Highly Suitable
	Expert 2	4.7		94%	Highly Suitable
Material Expert Validation	Expert 1	4.65	5.0	93%	Highly Suitable
	Expert 2	4.15		83%	Highly Suitable
Average Expert Test Result				91.75%	Highly Suitable

Based on the expert validation results, the media expert scores were 97% and 94%, while the material expert scores were 93% and 83%. The overall average validation score reached 91.75%, which falls into the “very suitable” category. These results indicate that the developed board game-based learning media meets the feasibility criteria and is appropriate for classroom implementation.

Following the validation process, several revisions were made to improve the product. The revisions included refining the clarity of instructions, adjusting the visual layout of the board, revising ambiguous question items, and improving the consistency of terminology related to distance and displacement concepts. After these revisions, the product was re-evaluated and remained in the “very suitable” category.

#### 4. Implementation

The implementation stage was conducted through small-scale and large-scale trials using a pre-test and post-test design to measure students' improvement after using the JAPERU board game. The results of both trials, including pre-test mean, post-test mean, N-gain score, N-gain percentage, and category, are summarized in Table 2.

Table 2. Small-Scale and Large-Scale Trials Result

Trial Type	N	Pre-test Mean	Post-test Mean	N-gain	N-gain (%)	Category
Small-Scale	8	47.5	80	0.56	56%	Moderate
Large-Scale	25	56.8	81.6	0.56	56%	Moderate

##### 1) Small-Scale Trial

The small-scale trial involved 8 seventh-grade students. The average pre-test score was 47.5, which increased to 80 in the post-test. The calculated N-gain score was 0.56, which categorized as moderate. Based on Table 2, the result indicates that the use of the JAPERU board game was able to improve students' understanding of distance and displacement concepts at a moderate level during the initial implementation.

##### 2) Large-Scale Trial

The large-scale trial was conducted with 25 students. The mean pre-test score was 56.8, which increased to 81.6 after the implementation. The obtained N-gain was 0.56, which is also categorized as moderate. Although the N-gain category remained moderate, the large-scale trial showed consistent improvement in students' conceptual understanding, indicating that the developed media was effective when implemented in a broader classroom setting.

#### 4. Evaluation

The evaluation stage was conducted based on student response questionnaires administered after both the small-scale and large-scale trials. The questionnaires assessed students' perceptions of the JAPERU board game in terms of engagement, ease of use, and overall learning experience. The evaluation results from both trial stages are presented in Table 3.

Table 3. Students Evaluation Results

Trial Type	Number of Students	Evaluation Percentage	Category
Small-Scale	8	85.625%	Very Good
Large-Scale	25	94.52%	Very Good

The interpretation of the evaluation results was based on percentage criteria, where a score of 81–100% is categorized as “very good,” 61–80% as “good,” 41–60% as “fair,” 21–40% as “poor,” and 0–20% as “very poor.” Based on these criteria, the small-scale trial obtained an evaluation percentage of 85.625%, which falls into the “very good” category. In the large-scale trial, the evaluation percentage reached 94.52%, which is also categorized as “very good.” The higher percentage in the broader implementation suggests that the developed media was increasingly well-received when used in a full classroom setting.

#### Discussions

The findings of this study show that the implementation of the JAPERU board game was able to improve students' conceptual understanding of distance and displacement, as indicated by the moderate N-gain scores (0.56) in both small-scale and large-scale trials. Although the improvement was not categorized as high, the consistent

increase in post-test scores demonstrates that the developed media contributed positively to students' learning outcomes. This is consistent with previous studies showing that game-based learning can enhance students' conceptual understanding in science subjects (Prasetyo & Wijaya, 2019; Sidarta & Yuniarta, 2019). Interactive learning experiences, such as board games, support students in reconstructing their understanding of abstract physics concepts through active engagement and repeated practice (Ardianti et al., 2025).

In addition to interactive activities, the visual design of the JAPERU board game also played an important role in supporting learning. The use of attractive colors, clear typography, structured board layouts, and illustrative representations of motion concepts helped transform abstract ideas into more concrete and understandable forms. Visually organized materials can reduce cognitive overload and assist students in focusing on essential information (Ate et al., 2025). An appealing visual presentation not only increases students' interest but also supports comprehension by linking conceptual explanations with concrete visual cues (Sadiman et al., 2010).

Distance and displacement are concepts that are often perceived as similar by students, leading to misconceptions and confusion (Yolanda, 2017). The moderate improvement observed in this study indicates that conceptual change in physics does not occur instantly but develops gradually through meaningful learning experiences (Klein et al., 2019). By engaging students in active participation, discussion, and problem-solving activities, the board game provided opportunities for students to clarify misunderstandings and strengthen their conceptual distinctions, in line with findings from Shreshta et al. (2023) who emphasize the importance of interactive strategies in addressing learning difficulties in junior high school physics.

The high percentage of positive student responses in both trials (85.625% and 94.52%) further supports the effectiveness of the developed media. Students perceived the learning process as more engaging and enjoyable compared to conventional lecture-based instruction. Increased engagement and motivation likely contributed to better attention and deeper cognitive processing, which in turn supported conceptual understanding (Taufik et al., 2023). When students are actively involved in learning activities rather than passively receiving information, they are more likely to construct their own understanding of the material (Septripiyani et al., 2025).

The results of the needs analysis also align with these findings. A significant number of students expressed a preference for game-based learning media and identified motion topics as suitable for such approaches. The alignment between students' needs, the developed media, and the observed improvement in learning outcomes indicates that instructional design that responds to learners' characteristics and difficulties can enhance classroom effectiveness (Adeoye et al., 2024).

Although the improvement was categorized as moderate, this result remains pedagogically meaningful. Understanding abstract motion concepts requires continuous reinforcement and practice (Ardianti et al., 2025). Therefore, the consistent improvement across both implementation stages suggests that the JAPERU board game is a feasible and effective instructional innovation that enhances engagement while supporting the gradual development of conceptual understanding in physics learning.

## CONCLUSIONS

Based on the results of this research, it can be concluded that the JAPERU board game-based learning media is feasible and effective in improving seventh-grade students' understanding of distance and displacement concepts. The expert validation results categorized the media as highly suitable, and the implementation findings showed consistent improvement in students' pre-test and post-test scores with a moderate N-gain (0.56), indicating meaningful enhancement in conceptual understanding. In addition, students responded very positively to the learning process, demonstrating increased engagement and participation. Therefore, it is recommended that teachers integrate JAPERU or similar game-based learning media into physics instruction to create more interactive and meaningful classroom experiences, and future research is expected to implement the media over a longer duration and expand it to other physics topics to further optimize learning outcomes.

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