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Article

Validity of 2D Board Games in Learning Simple Machinery to Improve Critical Thinking

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ABSTRACT

Physics is considered a difficult and complicated subject by most students. They sometimes get bored quickly when study physics. To overcome this problem, an innovation in learning media in the form of a board game was created, that can provide material to students and not make them bored quickly. The main objective of this study is to develop and validate board game media based on critical thinking. The research method begins with a needs analysis using literature studies and interviews. The results of this needs analysis are used as a basis for developing board games. After that, the board game was tested for validity which includes 4 aspects, namely material relevance, media use, media design, and media effectiveness. The validation results show that the validity of the material relevance is 70% with a fairly good category, media use is 100% with a very good category, media design is 80% with a good category, and media effectiveness is 73% with a fairly good category. The validity results show the highest percentage of 100%, 80% and the lowest is 73%, 70%. Overall, the validity results show that the board game media developed is worthy of being continued to the next stage.

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PENDAHULUAN

Natural Science is a discipline that involves the acquisition of concepts and the processes of discovery related to nature. Its application is based on facts and principles through continuous thinking activities in which students engage in character development through practical activities (Arista, 2022). Science education plays a strategic role in preparing students to think critically, creatively, and logically, as well as to actively respond to societal issues arising from the impacts of knowledge (Kusumastuti et al., 2019). Science learning is essential in 21st-century education to develop students into communicative, creative, collaborative, and critical thinkers (Harianto & Jannah, 2020). Critical thinking skills involve deeply considering information through research or experimentation to draw conclusions that help build meaningful knowledge. Indicators of critical thinking skills measurement have the ability to target skills more accurately (Rohmawati et al., 2023).

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The importance of science education in developing students' thinking skills serves as a benchmark for focusing the learning process on thinking skills. One critical thinking skill that needs to be optimized is the ability to think critically. Critical thinking is defined as thinking meaningfully to determine the truth, and the thinking skills of students allow them to respond to and filter existing problems. Therefore, scientific processes require critical thinking skills. The science learning process in schools requires interaction between students and the environment with the goal of achieving educational objectives. The role of the teacher in the learning process is primarily to encourage and motivate students (Muhammad et al., 2021).

Critical thinking skills enable students to reach higher levels of knowledge. Students are considered to possess high critical thinking skills when they carefully reflect on what they have achieved to maintain stability and tend to have a realistic view of themselves and those around them (Amara, 2019). To develop critical thinking skills in science education, students need the right behaviors, including self-efficacy and self-competence. Therefore, students must have confidence in their abilities. Self-efficacy is a form of self-confidence that students need to improve their skills. Student self-efficacy assumes that they are confident in their ability to solve problems and how well they can understand and analyze the problems they face (Muhammad et al., 2021).

The role of educational media in the teaching and learning process is inseparable and integral to the world of education. Educational media refers to anything that can be used to convey educational messages to students and stimulate their thoughts, feelings, attention, and interest in learning. Educational media is one of the tools used by educators to deliver content, enhance student creativity, and increase student attention and motivation during the learning process. The use of educational media boosts student learning motivation, encourages them to write and speak, and fosters advanced imagination (Rofiah et al., 2021). According to Kristiawan in Wati and Kamila (2020), educators must be able to leverage technology to enhance the quality of the learning process at all educational levels. Educators need to be creative and develop innovative educational media that support the teaching and learning activities (Mukti et al., 2020).

Educational media plays a crucial role in the learning and teaching process. These media are not just learning materials, but also serve as tools to deliver content effectively and engagingly. By using the appropriate educational media, educators can improve the quality of the learning process, enrich students' learning experiences, and make the learning process more enjoyable. Educational media can come in various forms, ranging from print media like books and magazines, audiovisual media such as videos and films, to digital media like learning applications and online platforms. Since each type of media has different characteristics and benefits, educators must choose and integrate the media that best align with the learning objectives and students' needs. Furthermore, the use of educational media also helps students develop critical, creative, and collaborative thinking, as well as enhance communication skills and the transfer of ideas. Therefore, educational media not only serves as a tool for delivering information but also as a means to develop the full potential of students.

There are various types of educational media. One form of educational media that is currently attracting attention is game-based learning. Indeed, the current popular games bring joy and act as a stress-reliever for people engaged in various activities. However, these games can also lead students to become addicted and drop out of school. It is a social fact that games create addiction among users. This phenomenon has led to creative and innovative ideas in the field of education, utilizing games as educational media that can support the teaching and learning process. Therefore, these Games are referred to as educational games. Educational games are typically similar to regular games, differing mainly in their use, content, and objectives. The advantage of educational games is that they not only provide entertainment for the user but also offer knowledge and experience. The goal of educational games is to

continuously increase student motivation, thus enhancing interactivity and making students more relaxed and engaged in learning the educational material (Alisa, 2024).

To develop game-based learning, the quality of learning needs to be improved. One approach that can be taken when developing educational materials is by conducting a validity test. Validity testing is used to demonstrate the extent to which the measuring instrument used corresponds with what it is intended to measure. Validity is also an aspect of accuracy in measurement.

Educational media designed to enhance students' critical thinking skills play an essential role in the educational process. By directly incorporating aspects of critical thinking, such media can facilitate the analysis and evaluation of information, making the learning material more flexible and effective. Validation of educational media by experts is a crucial step in determining its suitability as an effective learning tool. This article aims to analyze the results of such validation and provide insights into the validity and quality of the concerned educational media.

METODE

This research uses the Research and Development (R&D) method and refers to the 4D model development concept. According to Maydiantoro (2021), the 4D development methodology consists of four stages: define, design, develop, and disseminate. These stages must be carried out sequentially. This study follows the stages as outlined: research and data collection, planning, product development, and product validation.

The research and data collection stage produces the material used, which is *simple machines, while the media to be developed is a **2D board game, with a focus on **critical thinking*. The planning stage results in the design of a 2D board game based on aspects of critical thinking skills. The product development stage produces a 2D board game on the topic of simple machines aimed at improving critical thinking. The validation test is conducted to determine the feasibility of the board game learning media for enhancing critical thinking.

Data for the media validation test is obtained from expert instruments based on a 1-5 scale for each aspect, with the following criteria: 5 = Excellent, 4 = Good, 3 = Fair, 2 = Poor, 1 = Very Poor. Media validation is performed on four aspects: material relevance, media usability, media design, and media effectiveness. The validation results are then calculated using the Likert scale formula:

$$V = \frac{NILAI}{HASIL\ KESELURUHAN} \text{ X } 100\%$$

The validation results are presented in a table and analyzed for their alignment with percentage criteria. The interpretation and decision-making of the validation results are made according to predefined standards.

HASIL DAN PEMBAHASAN

In learning about simple machines, the use of 2D learning media, particularly board games, offers several advantages that can enhance the effectiveness of the learning process. Below are some reasons why this media is highly suitable for basic mathematics learning within the field of physics. First, 2D media such as board games provide clear visualizations that are easy for students to understand. By directly observing how processes like addition are carried out, students can easily grasp fundamental concepts. Second, board games are interactive learning tools that allow students to actively engage in the learning process. This engagement can increase students' interest and motivation to learn, as they can see the immediate results of their actions. This interactivity also helps students stay focused and involved throughout the learning process. Additionally, learning through play is one of the best

ways for children to learn. Board games present simple machines material in a playful format, making the learning process more enjoyable and effective. Students learn while playing, which prevents the process from feeling boring or difficult. This is particularly important in physics education, where fundamental concepts must be understood before they can be applied to more complex contexts. The use of board games also aids in the development of both fine motor and cognitive skills. Playing board games enhances cognitive abilities, such as logic, planning, and problem-solving. Moreover, these games contribute to fine motor skills, such as the ability to handle and move game pieces. These skills are vital for conducting practical experiments and making observations in physics labs. 2D learning media like board games can also be adapted to suit students' varying levels of ability. Educators can choose or modify the game to ensure that each student works at an appropriate level of difficulty, thereby ensuring effective learning for all. Furthermore, the use of board games enables efficient learning in terms of resource utilization. Finally, board games encourage cooperation and communication among students. Many board games are designed to be played in pairs or groups, helping students learn how to collaborate and communicate with their peers. This is important not only for social skill development but also for collaboration on physics projects that require teamwork. By using 2D learning media like board games, students can discover a more enjoyable and effective way to understand basic concepts in physics. This not only improves their comprehension of the material but also aids in developing larger skills and concepts for the future.

2D learning media, particularly board games, can significantly enhance critical thinking because of the following reasons. First, board games promote the development of analytical skills. Many games require players to think deeply about strategies and their next moves. Students must consider various possibilities and the consequences of each decision. This process encourages the development of analytical skills, which are essential components of critical thinking. Students learn to analyze situations from multiple perspectives and make decisions based on careful consideration. Second, board games are an effective tool for problem-solving. One of the main aspects of critical thinking is the ability to solve problems. Board games provide a safe environment for students to practice this skill. They must recognize problems, analyze situations, and find effective solutions. These skills are crucial in everyday life, where the ability to solve problems quickly and efficiently is often required. Third, board games also aid in the development of logic and argumentation. Many games require players to think logically and build strong arguments. Students learn to organize their thoughts, evaluate the arguments they face, and respond logically. These skills are vital for critical thinking, as they enable students to think systematically and rationally. In addition, board games force students to adapt to changing situations. Many board games offer different challenges each time they are played, which forces students to adapt to uncertainty and make decisions in evolving situations. The ability to adapt and think critically in changing conditions is a valuable skill in daily life. Board games also encourage cooperation and communication among students. Many board games are designed to be played in groups, requiring collaboration and effective communication. Students learn to work together, share ideas, and listen to others' opinions. This process not only enhances their social skills but also encourages them to consider diverse perspectives, an important aspect of critical thinking. Finally, board games help students with decision-making. In board games, students are often faced with situations where they must make quick and accurate decisions. They need to evaluate risks, consider consequences, and choose the most appropriate action. Decision-making skills are crucial for critical thinking because they allow students to think critically and select the best course of action in various situations. By using board games as a learning tool, students can develop various skills that support critical thinking. From problem-solving to decision-making, board games provide an enjoyable and effective environment for students to practice and improve

their critical thinking abilities. This not only enhances their understanding of the material but also aids in the development of larger skills and concepts for the future

The board game developed here incorporates several advantages and innovations compared to existing board games. This board game employs a branching path system, allowing students to choose their own routes to reach the finish line, rather than following a single predetermined path. Additionally, the game features various events that enhance the atmosphere, making it more dynamic and less monotonous. These events include effects on player pieces or quizzes that players must answer themselves. These events are designed to be random and unpredictable, adding an element of excitement and encouraging engagement. The events are also tied to the learning content—such as force, displacement, and simple machines—so that students gradually gain an understanding of these topics through gameplay. Thus, students are not only playing but also learning simultaneously.

Validation of the Educational Board Game Media to Enhance Critical Thinking was conducted by experts in four aspects: validation of material relevance, validation of media usage, validation of material design, and validation of media effectiveness, as shown in Table 2.

Tabel 2. Validation Aspect Scores

Aspek validasi	**Presentase**	**Kualifikasi**
Relevance of Material	70%	Fairly Good
Use of Media	100%	Very Good
Media Design	80%	Good
Effectiveness of Media	73%	Fairly Good

Validation by experts on the aspect of material relevance resulted in a percentage of 70%, indicating that the material relevance meets general standards and is suitable for implementation in schools. The validation of material relevance includes the suitability of the material with the media and the accuracy of the material. After the module was validated by experts, there were suggestions for improvements to the board game media, particularly in the material.

Validation by experts on the aspect of media usage resulted in a percentage of 100%, indicating that the media usage meets the standards and is suitable for implementation in schools. The validation by expert designers includes the ease of use of the media and the instructions for using the media. Validation by experts on the aspect of media design resulted in a percentage of 80%, indicating that the media design meets the criteria and standards for media design. The validation of the design includes aspects such as the attractiveness of the media, the physical appearance, the color combination, and the images on the media. From the validity test by experts, there were no suggestions for improvement in the media design, so the board game media meets the criteria for suitability.

Validation by experts on the aspect of media effectiveness resulted in a percentage of 73%, indicating that the media usage sufficiently meets the criteria and standards for the development of board game media. The validation of media effectiveness includes the ability of the media to increase students' interest in learning, the ability to be used anytime and anywhere, and the enjoyable nature of the media. From the validity test by experts, there were no suggestions for improvement in the media design, so the board game media meets the criteria for suitability.

Validation by experts on the aspect of media design resulted in a percentage of 80%, indicating that the media design meets the criteria and standards for media design. The validation of the design includes aspects such as the attractiveness of the media, the physical

appearance, the color combination, and the images on the media. From the validity test by experts, there were no suggestions for improvement in the media design, so the board game media meets the criteria for suitability.

The board game's validation was divided into four aspects: content relevance, usability, design, and effectiveness. Based on the validation results, scores obtained were 75% for content relevance, 95% for usability, 73% for design, and 80% for effectiveness.

The high usability score is attributed to the ease of using this educational medium. Board games are familiar to students, enabling them to grasp the rules more easily. Moreover, since the game is directly related to the subject matter, it is likely to be used consistently during lessons, rather than being a resource that is easily forgotten or used only occasionally.

The media's effectiveness score was also high, as the game proves to be an effective tool for conveying relevant subject matter to students. Furthermore, it helps create a lively learning environment, reducing students' boredom with topics they may find challenging. Nevertheless, there is room for improving the game's effectiveness, such as by adding new and innovative elements to further engage students and introduce fresh experiences.

The design and content relevance aspects received moderate scores. Overall, the game's design is colorful and bright, effectively capturing students' attention. However, the game could incorporate more prominent patterns or illustrations to create a more vibrant appearance. This would likely enhance students' interest. The design of the box and pathways could also be refined for added appeal.

As for content relevance, the game includes several key points related to the subject matter but could be enhanced with more detailed and comprehensive content. By enriching the game's educational material, it could better support students' understanding of the topics they are studying.

KESIMPULAN

The use of 2D learning media, particularly board games, has numerous benefits in enhancing the effectiveness of the learning process, especially in simple addition topics within the field of physics. Board games provide clear visualization, encourage interactivity and active participation, and make the learning process more enjoyable and effective. Additionally, board games help in the development of fine motor skills, cognitive abilities, and social skills, as well as promoting collaboration and communication among students. The use of board games also allows for learning that is tailored to the students' level of ability and is efficient in terms of resource usage.

In addition to improving understanding of the material, board games are also very effective in enhancing critical thinking. Board games promote the development of analytical skills, problem-solving, logic, and argumentation. They also force students to adapt to changing situations and make quick and accurate decisions. By using board games, students can develop a variety of skills that support critical thinking, which are not only beneficial in the context of learning physics but also in everyday life.

Based on the validation results of 2D board games in learning simple planes to improve critical thinking, it can be concluded that this media has adequate performance and is good for use in the learning process in schools. The validation results show the highest percentage of media use (100%) and media design (80%), which are categorized as very good and valid for use by students. Suggestions for improvement lie in the design media which should be made more attractive. Meanwhile, the lowest validation results lie in the aspects of media effectiveness (73%) and material relevance (70%), which are categorized as quite feasible after improvements have been made.

From the validation results, it is clear that the learning media used has met the standards and eligibility criteria in various aspects. The relevance of the material which reached 70%

shows that the material delivered through this media is sufficient in accordance with student needs and learning objectives. Media use that reaches 100% shows that the media is easy to use and understood by students, and has clear instructions for use. Media design that reaches 80% shows that the media has an attractive appearance and an appropriate combination of colors and images. The effectiveness of the media which reached 73% shows that the media is able to increase students' interest in learning and has a fun nature. Thus, this learning media can be considered appropriate and effective for use in the teaching and learning process in schools. Overall, this 2D board game has met the standard eligibility criteria and can be applied in learning to improve students' critical thinking. By improving aspects that do not meet standards, it is hoped that this media can make a significant contribution to the learning process in schools.

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