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Article

DEVELOPMENT OF THERMOQUEST LEARNING MEDIA: EXPLORING THE WORLD OF TEMPERATURE, HEAT AND EXPANSION THROUGH EDUCATIVE BOARD GAMES

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ABSTRACT

This research aims to develop and evaluate learning media based on the Monopoly board game to increase understanding of the physical concepts of temperature, heat and expansion. The development method used is the Multimedia Development Life Cycle (MDLC) until the testing stage. Monopoly game media is designed to provide an interactive and immersive learning experience that integrates game elements with physics concepts. Data analysis uses qualitative descriptive analysis. The trial results show that Monopoly learning media received the highest assessment in functional aspects and aspects of interactivity and player involvement with a respective feasibility percentage of (85.00%). Meanwhile, the lowest aspects are readability of media material (80.00%), learning effectiveness (80.00%) and suitability to learning objectives in the curriculum (70.00%). Monopoly learning media meets the eligibility criteria by achieving an average of 80.00%. Thus, ThermoQuest learning media is worthy of being developed to the next stage.

INTRODUCTION

Science education has a crucial role in developing students' intellectual capacity in meeting daily needs by helping to overcome identifiable problems. Among the various branches of science, physics has a central role in understanding the basic principles of natural phenomena in everyday life and phenomena that occur in the universe (Cynthia et al., 2023). Through understanding physics, students can apply critical reasoning and in-depth analysis in solving challenges related to natural phenomena, providing value in everyday life, and important in the development of 21st century skills such as critical thinking, collaboration, creativity and communication (Purfiyansyah et al., 2023).

The physics concept of thermal expansion is an important aspect of science literacy, and therefore, it is not surprising that the topic of thermal expansion has a place in the science curriculum at all levels of education (Vidak et al, 2019). However, temperature, heat and expansion materials are often considered difficult to understand by some students. Research by Alwan, 2011; Irawati & Sofianto, 2018 revealed that many students experience confusion regarding the concepts of heat and temperature, and have difficulty articulating the difference between the two, and some even still equate the terms "heat" and "temperature".

Learning media is an intermediary or tool used to convey an idea or material so that it can stimulate students' thoughts, attention and interests so that the teaching and learning process occurs in students (Cahyadi, 2018). In line with what Ruth Lautfer said (in Tafonao, 2018); Kandia et al, 2023 that learning media is one of the means used by teachers to present material with the aim of increasing creativity and student concentration levels during the teaching and learning process. The learning media used includes various forms, such as videos, graphics, photos, slides, and also learning through games (Kristanto, 2016). Videos provide dynamic visualization, graphics and photos clarify concepts, while slides present information in a structured manner. Game learning adds an interactive dimension and brings learning material to life, allowing learners to be actively involved in the learning process.

The selection of learning media adapted to the characteristics of the material accompanied by the use of relevant methods will create good quality education (Hasan et al., 2021). In addition, learning media must be designed attractively and can make students interactive, so that students can learn in a fun way so as to form a comfortable and conducive learning atmosphere. One promising approach is to utilize the popularity of board games as a means to facilitate students' understanding of temperature, heat and expansion materials. Research by Ramadhani et al, 2016; Wang & Zheng, 2021; Handican et al, 2023 proved the effectiveness of using a game-based approach in increasing student engagement and deepening their understanding of scientific concepts.

In this context, the board game Monopoly offers significant potential. By combining competitive elements and game strategies with relevant physics concepts, it is expected that students will be able to better understand and internalize the concepts of temperature, heat and expansion. Only with a strong understanding of physics concepts, students can solve various physics problems, including in everyday life (Dewi et al., 2012; Sari et al., 2022). However, to date, systematic studies related to the use of Monopoly as a learning medium in the context of temperature, heat and expansion are still limited. This research aims to fill the gap by exploring it further. By using a modified Monopoly board with the addition of quizzes, it is expected that students will be actively involved in the learning process, strengthening and consolidating students' understanding of the concepts of temperature, heat and expansion. The benefits of the media are to increase students' understanding and motivation to learn.

METHODS

Media development was conducted during September 2023. The target of the research is the development of learning media for temperature, heat and expansion material implemented in the form of a Monopoly game called 'ThermoQuest'. The system approach method used is the Luther-Sutopo version of the Multimedia Development Life Cycle (MDLC) method, which consists of six stages, namely concept, design, material collecting, assembly, testing, and distribution (Setiawan et al, 2016). However, the distribution stage was not carried out, because the research was only limited to trials. The following is a flowchart of the stages of the MDLC method.

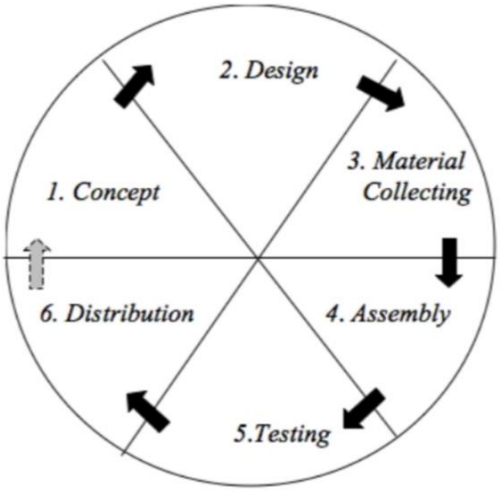

Figure 1. Stages of the MDLC Method (Mustika et al., 2017)

1. Concept

At the concept stage, researchers make arrangements, among others:

a. Determining the learning objectives to be achieved through the use of learning media on temperature, heat and expansion materials,
b. Determining who are the users of ThermoQuest monopoly learning media.
c. Describing the components of monopoly media.
d. Determine how to play

2. Design

The game board and other game elements are designed in detail, including determining the location and structure of each box on the board, determining transaction elements such as general funds, opportunity cards, money as transactions, and quiz questions, as well as developing game rules that integrate game aspects with learning objectives

3. Material Collecting

The materials to be used in the Monopoly game were collected including materials related to the concepts of temperature, heat and expansion that would be presented to the player as intellectual challenges, game assets, as well as other elements that could be obtained for free or by ordering from other parties according to the design.

4. Assembly

All game components such as the board, opportunity cards, general funds and other transaction elements are produced and assembled according to the planned design. The Monopoly game board and all its elements are carefully assembled to ensure compliance with the learning objectives.

5. Testing

The data collection method used a media feasibility assessment sheet evaluated by two lecturers of Tadris IPA IAIN Ponorogo. The results of the study were analyzed descriptively qualitatively by paying attention to the aspects of monopoly game media development, including functionality, material readability, learning effectiveness, interactivity, player involvement, emotional effects, and suitability for learning objectives in the curriculum. The following formula is used to show the percentage of results.

$$\text{Percentage of eligibility} = \frac{Total\ scoring}{Maximum\ score} \text{ x } 100\%$$

The eligibility criteria are based on the following parameters (according to Arikunto, in Ernawati & Sukardiyono, 2017)

Tabel 1. Media eligibility criteria

No	Score in Percent (%)	Eligibility Category
1	<21 %	Very Unfeasible
2	21 - 40 %	Not Feasible
3	41 - 60 %	Feasible Enough
4	61 - 80 %	Worth
5	81 - 100 %	Very Feasible

RESULTS AND DISCUSSION

The results of the ThermoQuest Monopoly game media trial provide an interesting picture. In the trial, several important aspects were evaluated to measure the extent to which learning media can provide benefits to students. The trial results can be seen in table 2.

Table 2. Trial survey results

No	Indicator	Average percentage of feasibility	Eligibility category
1	Functional Aspect Components of the Game	85%	Very Feasible
2	Readability Component	80%	Worth
3	Component Aspects of Learning Effectiveness	80%	Worth
4	Component Aspects Interactivity and Player Engagement	85%	Very Feasible
5	Component Aspect Conformity with Learning Objectives in the Curriculum	70%	Worth

After going through the validity test, both science lecturers provided valuable input related to the learning process. There are still shortcomings in the conceptualization of temperature, heat and expansion for students. Although the learning media has been presented with innovation and color, in accordance with the developmental stage of junior high school children, they suggest the addition of clear learning objectives to strengthen the impression of learning. In addition, it is necessary to consider the duration of playback, considering that too long a time can reduce the effectiveness of achieving learning outcomes. By listening to the suggestions from both science lecturers, the learning media can be improved to provide a more effective and satisfying learning experience for students.

Based on Table 2, the component with the highest percentage is Aspect Functionality of the Game and the Interactivity and Player Engagement Aspects both reached 85%. Meanwhile, the three categories with the lowest percentage are Material Readability Aspect, Learning Effectiveness Aspect with a percentage, both reaching 80% and Aspect of Conformity with Learning Objectives in the Curriculum reaching 70%. It can be concluded that the Functional Aspect of the Game and the Interactivity and Player Involvement Aspect are the categories that received the highest assessment, while the Readability Aspect of the Material, the Learning Effectiveness Aspect and the Conformity Aspect with the Learning Objectives in the Curriculum received the lowest assessment.

The Functional Aspect of the Game received a high rating as it fulfills important indicators. First, the ease of understanding and use of the game board provides an intuitive

experience for players, allowing them to focus on the essence of the concepts being taught. Secondly, consistency in the game rules and transaction process provides a clear and consistent structure in the interaction between players, reducing confusion and increasing learning effectiveness. Meanwhile, the Interactivity and Engagement Aspect also received high ratings for meeting crucial indicators. First, the level of interaction between players during Monopoly game play provides opportunities for students to learn through social interaction and collaborate in solving challenges. Secondly, the involvement of players in solving challenges related to the concepts of temperature, heat and expansion shows that the game media is effective in facilitating in-depth understanding of complex material. Overall, the high ratings from both aspects indicate that the Monopoly game succeeds in creating an interactive, engaging learning experience and enables deeper concept understanding for students.

The readability aspect of the material received a low rating because there were problems related to the readability and clarity of the text on the game board. Some parts of the text may not be clear enough or difficult for students to understand, which can hinder optimal understanding of concepts. In addition, explanations regarding the concepts of temperature, heat and expansion on each element of the game board do not always reach the desired level of clarity, which can cause confusion for students and reduce the effectiveness of the learning process. Furthermore, the Learning Effectiveness aspect received a low rating because it was necessary to reconsider the way of conveying and teaching the concepts of temperature, heat and expansion as well as the lack of variety in quiz questions which remained the same if played repeatedly, causing a level of boredom. The evaluation shows that there is room for improvement in teaching methods and variations in question content to enable students to achieve deeper understanding. Finally, the aspect of Conformity to the Curriculum also received a low rating because it did not fully support the learning objectives set out in the applicable curriculum. More consideration and integration of elements in accordance with the curriculum is needed to ensure that game media effectively supports students' learning processes in accordance with applicable curriculum standards.

To improve the readability of the material, an in-depth revision of the text presented on the game board is required. The use of appropriate terminology and well-structured sentences can make it easier for students to understand the concepts presented. The use of clear and concise language will minimize ambiguity in the interpretation of information. In accordance with recent research in the field of instructional design that emphasizes the importance of text clarity to improve learning effectiveness (Wijayanto, 2018). Thus, the text enhancement on the game board will be makes a significant contribution in making it easier for students to understand and master the material taught.

Efforts to increase learning effectiveness are by considering the use of augmented reality technology and adding quiz questions periodically. By integrating augmented reality in a game board, it can provide students with a more interesting and interactive learning experience and increase the level of concept retention by students because they can visually see and interact with the material being taught. Apart from that, the use of augmented reality can also increase student learning motivation, providing more interesting and interactive learning, which in the end can improve learning outcomes significantly. Previous research shows that the use of augmented reality technology can improve understanding of physics concepts (Ismail, 2021; Novita, 2023). Then an automatic updating system that periodically adds new questions can provide continuous variety without requiring manual intervention. Meanwhile, the application of artificial intelligence technology can be used to create questions tailored to each player's level of understanding and progress, creating a personalized and challenging learning experience. This solution can overcome boredom by providing challenges that suit individual abilities.

To ensure compliance with the applicable curriculum, an in-depth analysis of the learning objectives set out in the curriculum is required. By clearly understanding what is desired from the learning process, the elements that need to be emphasized in the Monopoly game can be identified. After that, the game can be adjusted by incorporating instructional elements that are in line with the curriculum objectives, which can include the integration of materials, challenges, or interactions between players that support the achievement of the learning objectives that have been set. Adjustment to curriculum objectives is in line with the curriculum-based learning approach that emphasizes the importance of integrating materials with established learning objectives (Sugiana, 2018). Ensuring that every element in the game consistently supports the established learning objectives will ensure conformity with the applicable curriculum. Thus, students can better understand the relevance of the material and how it relates to their learning objectives.

The importance of considering the playback duration in the Monopoly game is to ensure that students remain engaged and focused during the learning process. Too long a time can lead to student fatigue and loss of interest, which in turn can reduce effectiveness in achieving learning objectives. Therefore, efforts should be made to set an optimal playback duration, tailored to students' concentration and endurance levels. In addition, utilizing active and interactive teaching strategies during the playback can also help maintain the level of student engagement. Continuous monitoring of student responses and engagement during playback is key in ensuring that the duration is appropriate and maximizes learning effectiveness and it is important to find the right balance between the duration of learning activities and the desired learning outcomes (Paolini, 2015).

CONCLUSION

ThermoQuest, the Monopoly learning media developed, shows potential in increasing understanding of the physical concepts of temperature, heat and expansion. Even though it received a high assessment on the functional and interactivity aspects, it needs improvement regarding the readability of the material, learning effectiveness and suitability to curriculum objectives. Thus, ThermoQuest learning media is worthy of being developed to the next stage.

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