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Article

Ethnosocioscience-Based 3D AR Diorama as a Learning Medium Science on Rigid Object Equilibrium through the Peacock Dhadak Reog Ponorogo

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ABSTRACT

Science learning is often presented abstractly and lacks contextual relevance, particularly in the topic of rigid body equilibrium. This study aims to develop a learning medium in the form of an ethnosocioscience-based Dhadak Merak Reog Ponorogo diorama to enhance students' conceptual understanding and engagement. The research employed a development model consisting of expert validation, readability testing, and student response analysis. Validation results indicated that the diorama was valid and feasible for classroom use. Readability tests showed that the learning materials were clear and easily understood by students. Student responses were highly positive, demonstrating increased interest, motivation, and comprehension of physics concepts. The findings suggest that the Dhadak Merak Reog Ponorogo diorama is effective as a contextual and culturally relevant learning medium that integrates scientific concepts with local culture. This medium is recommended for broader implementation in science learning to promote meaningful understanding and support the goals of the Merdeka Curriculum.

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INTRODUCTION

Science education aims to equip students with a scientific understanding that enables them to explain and solve real-world problems in their environment. However, in practice, science instruction particularly in the topic of rigid body equilibrium is often presented abstractly through formulas and mathematical calculations without connecting these concepts to concrete realities familiar to students. Consequently, many students struggle to comprehend the principles of force equilibrium, torque, and their applications in daily life. This challenge is compounded by the use of instructional materials that lack contextual relevance and fail to integrate cultural or local environmental elements as learning resources (Fitriani et al., 2021). In fact, contextualizing scientific concepts through real-world phenomena is essential so that students not only memorize formulas but also develop critical thinking skills and meaningful understanding of scientific principles in everyday contexts.

A promising approach to bridging the gap between scientific concepts and students' cultural realities is ethnosocioscience, which integrates science with local social and cultural

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values. Ethnosocioscience allows students to understand scientific concepts through familiar cultural phenomena encountered in their daily lives. In this context, the traditional art of Reog Ponorogo, particularly its main property called Dhadak Merak, provides a culturally rich and pedagogically relevant example for teaching the concept of rigid body equilibrium. The Dhadak Merak, a large lion-shaped mask adorned with peacock feathers weighing approximately 30-40 kilograms, is carried by a dancer using only the strength of the jaw. This performance vividly illustrates key principles of physics such as force balance, center of mass, and torque. By using such cultural phenomena, students can learn physics not merely as an abstract discipline but as a living concept embodied in their own cultural environment. This approach aligns with the Merdeka Curriculum, which emphasizes context-based learning and character building through local wisdom.

In the local cultural context of East Java, Reog Ponorogo holds great potential as a science learning resource. Its main attribute, the Dhadak Merak, symbolizes not only artistic expression but also real-life applications of physics concepts. The dancer's ability to balance the heavy mask using jaw strength serves as a concrete representation of the principles of rigid body equilibrium, including the interactions of force, moment of force, and center of mass. Leveraging such cultural phenomena in science education promotes meaningful learning by linking physics concepts to students' social and cultural contexts.

Nevertheless, the integration of local culture into science education remains limited, both in terms of learning media and instructional approach. Teachers often depend on generic materials that are not aligned with students' cultural backgrounds. This disconnect hinders the realization of engaging, meaningful, and grounded science learning. The Merdeka Curriculum strongly advocates contextual learning that incorporates local wisdom as part of the effort to strengthen the Pancasila Student Profile, which emphasizes creativity, critical thinking, and cultural identity.

Based on these considerations, this study aims to develop a Dhadak Merak Reog Ponorogo diorama as a learning medium that integrates the ethnosocioscience approach in science instruction, particularly in teaching the concept of rigid body equilibrium. The objectives of this research are to: (1) design and develop a contextual learning medium that connects scientific concepts with local culture; (2) enhance students' engagement and understanding of physics concepts; and (3) evaluate the feasibility and effectiveness of the developed diorama in improving learning outcomes. Furthermore, this study seeks to explore the potential of integrating ethnosocioscience into science learning through cultural arts, thereby providing practical recommendations for teachers and curriculum developers in designing innovative and culturally responsive science instruction.

The research question addressed in this study is: How can an ethnosocioscience-based diorama be developed to effectively support the teaching of rigid body equilibrium concepts in junior high schools (SMP/MTs)? Specifically, the study aims to design and validate a culturally grounded learning medium that integrates scientific, social, and cultural dimensions into a cohesive learning experience.

The novelty of this research lies in the use of the Reog Ponorogo cultural art, particularly the Dhadak Merak, as a science learning medium based on the ethnosocioscience approach. Previous studies on Reog Ponorogo have predominantly focused on artistic and anthropological perspectives, while integrative research linking culture, science, and social contexts remains limited. This study introduces an innovative model of culturally grounded science education that supports the implementation of the Merdeka Curriculum and strengthens students' character through contextualized science learning.

METHOD

This type of research is Research and Development (R&D), which aims to develop a learning medium in the form of a 3D Diorama based on Augmented Reality (AR) using an ethno-socioscientific approach for science (IPA) learning, particularly on the topic of equilibrium of rigid bodies. The development model used is the 3D model, which consists of three main stages: Define, Design, and Develop. The Define stage involves identifying students' needs, exploring the relevance of science materials to the local culture of Reog Ponorogo, and assessing the potential integration of AR technology. In the Design stage, activities include developing the media concept, designing visual and textual content, and mapping the science core competencies (KD) and indicators to be integrated. The Develop stage covers the creation of both physical and digital media, feasibility testing, and expert validation to refine and perfect the learning medium.

The subjects of this research are instrument validators, consisting of learning media experts. The validators assess aspects such as visual appearance, content quality, and the usefulness of the media in science learning through a validation questionnaire. The instrument used in this research is a validation assessment sheet. The assessment format employs a 4-point Likert scale, ranging from a score of 1 (very poor) to 4 (very good). The Likert scale, introduced by Likert (1932), consists of four or more statements arranged to produce a value or score that reflects individual characteristics such as knowledge, attitude, or behavior (Budiaji, 2013). Validation was carried out on 15 indicators, covering aspects of visual display, content and material, and the function of the ethno-socioscientific-based learning media. The learning media validation sheet is presented in Table 1.

Table 1. Expert Validation Sheet Instrument for Learning Media

No.	Learning Media Component	Score			
		1	2	3	4
A	**Display**				
1	The media display reflects relevant local cultural values.				
2	The visual design of the media is attractive and not confusing for students.				
3	The text used in the media is clearly readable.				
4	The color composition and layout support content comprehension.				
5	The illustrations and symbols in the media are appropriate to the ethno-socioscientific context.				
B	**Content and Material**				
6	The content in the media aligns with the science curriculum and local context.				
7	The media presents content rooted in the cultural reality of the community.				
8	Scientific information is delivered in language that is easy to understand.				
9	The material connects scientific concepts with local wisdom.				
10	The media content encourages students to think critically and find solutions.				
C	**Function and Usefulness of the Media**				
11	The media increases student engagement in science learning.				

12	The media strengthens students' understanding of the local science context.				
13	The media can be used with various teaching methods.				
14	The media motivates students to explore local phenomena.				
15	The media contributes to strengthening cultural identity through science.				
Score:					
Total Score:					

Each validator assigns a score to each statement item based on their perception and assessment of the quality of the learning media. The scores given are then summed to obtain the total score for each validated aspect. Subsequently, the validation data are analyzed to determine the feasibility level of the learning media using the percentage formula as follows:

$$\text{Final Score} = \frac{\sum score\ obtanied}{\sum maximum\ score}$$

The results of the media validation test, obtained from the experts' evaluations, are used to measure the validity level of the developed media. The assessment is conducted using a 4-point Likert scale, and the results are then categorized according to the feasibility criteria presented in Table 2.

Table 2. Conversion of Actual Scores into a Four-Scale Value

Percentage	Criteria
78,84 - 100%	Very good / Highly feasible
55,76 - 76,92%	Good / Feasible
32,69 -53,84%	Fair / Less feasible
0 - 30,76%	Poor / Not feasible

RESULT AND DISCUSSION

A. Description of the Media Developed

The media developed is an ethnosocioscience-based 3D AR (Augmented Reality) diorama. This media is considered very suitable, engaging, and has the potential to inspire students to be more active in participating in the science learning process. A diorama itself is a small-scale three-dimensional representation of a scene used to show or explain a particular situation or event. It usually contains miniature three-dimensional objects such as small buildings, human figures, and various other elements (Evitasari & Aulia, 2022). This type of learning media is not in the form of printed modules, e-modules, worksheets, infographics, or comics, but rather a three-dimensional diorama equipped with AR technology. The combination of physical dioramas and AR aims to make learning more creative, interactive, and contextual, so that students can learn while recognizing aspects of local culture and understanding science material more broadly and deeply. The use of diorama learning media can also help improve student learning outcomes in Natural Science subjects (Rahmawati & Sati, 2021).

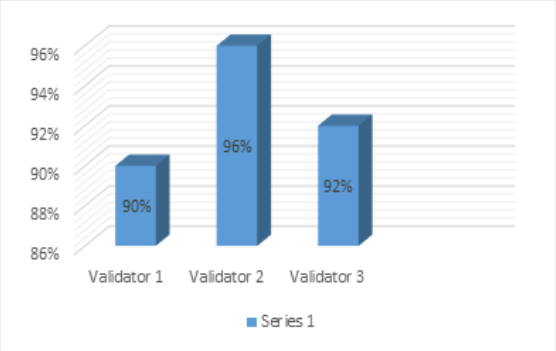
This 3D AR diorama has three panels, each presenting interrelated information and content. The first panel highlights the ethnoscience aspect, namely the history of Reog Ponorogo, the meaning of Dhadak Merak, and the cultural values contained therein. The second panel presents a comparison between local science (indigenous science) and scientific science, while connecting the physical principles of rigid body equilibrium,

center of gravity, moment of force, and support to Dhadak Merak. Meanwhile, the third panel is equipped with a QR marker, which when scanned using a device, will display 3D animations, simulations, and AR content that are useful for understanding the material in more detail and delving into cultural aspects more broadly.

The 3D AR diorama is designed in a triangular shape and each side is given a creative and educational visual display. The first side depicts Reog Ponorogo and Dhadak Merak, with writing and icons that are easy for students to understand. The second side emphasizes the scientific aspects, namely the equilibrium of rigid bodies, the center of gravity, and the moment of force, accompanied by graphs and schemes. The third side is given a QR marker, which when scanned, will display 3D animation and AR content on the device screen. The media display is given a harmonious color nuance and layout, so that students can learn while enjoying the visual aspects and available technology.

This 3D AR diorama media is closely related to the Basic Competence (KD) of Science for Grade VIII, namely KD 3.11 analyzing the dynamics of rigid body rotation and rigid body equilibrium in everyday life. With this media, students can achieve several learning indicators, such as understanding the principle of rigid body equilibrium, finding the center of gravity and moment of force, and connecting AR science and technology with cultural wisdom. With an ethnosocioscience approach and AR technology, this learning media is expected to make learning more meaningful, relevant, and able to increase student learning motivation, while also preserving the nation's culture.

B. Validation Results



The feasibility of the learning media, based on the analysis of three expert validators, yielded an average feasibility percentage of 92%. From these results, it can be concluded that the 3D AR Diorama learning media is highly suitable for use in science lessons to understand the equilibrium of rigid bodies through the dhadak merak (peacock) of the Reog Ponorogo dance. The use of this ethnosocioscience-based 3D AR Diorama media has the potential to improve the quality of learning, especially in terms of conceptual understanding and student skills. The 3D AR Diorama is not without its shortcomings. These shortcomings or suggestions are based on the analysis conducted by three expert validators, as follows:

Validator 1: There is insufficient emphasis on physics concepts; the material emphasis is not clearly focused; add formulas so that the material can be identified and used for teaching specific topics; the identity of the creator is missing (optional); add a little physics theory. Validator 2: The media is good (no suggestions were provided by the validators). Validator 3: It would be better to include formula derivatives appropriate

to the material to enhance students' critical thinking in linking physics theory and local wisdom.

Due to the shortcomings in the learning media that have been created, the author plans to improve and develop the Diorama learning media based on the suggestions given by the validator.

C. Discussion

This 3D AR Diorama Media has three panels, each presenting interrelated information and content. The first panel briefly explains ethnosociology and ethnosociophysics, as well as the history of Reog Ponorogo, the meaning of Dhadak Merak, and the cultural values contained therein. The second panel presents a comparison between local science (indigenous science) and scientific science, and explains the analysis of physics concepts in the process of making Reog Ponorogo. Where it applies the material on rigid body equilibrium learned in physics subjects. Meanwhile, the third panel is equipped with a QR marker, which when scanned using a device, will display a 3D Reog animation.

The 3D AR (Augmented Reality) Diorama media feature presents two QR markers that students can scan. In the AR depicts the reog. From this visualization, it is hoped that students can analyze the location of the rigid body equilibrium in the Ponorogo reog. The use of AR in learning media greatly helps students more easily understand physics concepts and local cultural practices, encourages the development of digital skills, and makes the learning experience modern and relevant to technological developments.

The cultural value integrated in the 3D AR Diorama media is the Reog Ponorogo. Reog Ponorogo art is a traditional art that has lived and developed from ancient times until now, which is said to contain historical and legendary values (Warsini, 2022). Reog art has many values and meanings. Thus, when integrated into learning, it will increase students' understanding of culture and can create a sense of love for local culture. In addition, this art also has character education values that can support student learning activities at school (Pertiwi & Sudrajat, 2022). So, Reog Ponorogo is not just an artistic performance, but an embodiment of cultural values and deep philosophy that have been passed down from generation to generation and can be integrated into learning because it contains moral values, character, physics concepts, etc.

Ethnosocioscience is the activity of transforming indigenous knowledge into scientific knowledge. Indigenous scientific knowledge consists of all knowledge regarding societal facts. Indigenous science is reflected in local wisdom as an understanding of nature and culture that develops within the community (Fauzana Nelmi & Risda Amini, 2023). The advantages of ethnosocioscience-based media in science learning include enabling students to connect the material learned in class with the context of their lives and the relationship between science and technology, improving students' scientific literacy and scientific character, developing students' sense of pride in cultural identity and appreciation for cultural diversity, increasing students' motivation and interest in learning, encouraging students to think critically, and so on.

CONCLUSION

This study successfully developed a 3D diorama learning medium integrated with Augmented Reality (AR) and the ethnosocioscience approach for teaching the concept of rigid body equilibrium using the cultural context of Dhadak Merak Reog Ponorogo. The validation results indicated a high level of feasibility, with an average score of 92%, confirming that the medium is appropriate for science learning. The implementation of the diorama not only enhanced students' understanding of physics concepts but also connected scientific knowledge with local culture, creating a more meaningful and contextual learning experience. Therefore,

this learning medium is recommended for broader application in science education across schools in alignment with the Merdeka Curriculum. Future research is encouraged to explore the integration of digital interactivity and cross-cultural comparisons to further strengthen contextualized science learning.

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