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Integration of Virtual Simulation of Traditional *Kekehan* Games on The Material of Moment of Inertia and Angular Momentum

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ABSTRACT

Objective: *The curriculum in Indonesia emphasizes learning with the 5.0 society era approach. The era of society emphasizes learning that is integrated with social culture. But in fact it is difficult to implement because students do not know the visualization of the concepts and problems discussed. Therefore, it is necessary to develop learning media that can provide visualization of problems and integrated social culture.* ***Method:*** *The method used is RnD with 3D design (Define, Design, Development) and the last stage of evaluation* ***Results:*** *The results obtained from this study are virtual simulation media integrated with traditional kekehan games getting a very valid criteria score. The results of students' responses show that virtual simulation media can already help students in helping physics problems. The evaluation results for improvement are related to the visualization of animation for kekehan so that it can move in the concept of moment of inertia and angular momentum.* ***Novelty****: To prevent the extinction of local culture, it is necessary to use a learning strategy with a local culture approach. One of the strategies that can be done is to provide visualization of cultural concepts in physics learning. Therefore, the purpose of this study was to analyze the validation of virtual simulation media integrated with traditional kekehan games and the response of students after using virtual simulation media integrated with traditional kekehan games.*

INTRODUCTION

The curriculum in Indonesia emphasizes learning with the era 5.0 society approach. Era 5.0 society focuses on humanism, prioritizing the development of scientific and technological innovation, which is the primary goal of development in the field of technology (Sudibjo et al., 2019). It impacts the world of education in the global sector (Awotunde et al., 2023), especially in improving creative thinking skills. Therefore, applying and providing a global problem in the era of 5.0 society is necessary for learning every material (Xu et al., 2021; Hysa et al., 2021). In addition, learning in the 21st century is not only a global problem. However, it must be able to link social and cultural problems in the era of society 5.0, which reflects technological developments and social interactions (Al-Emran & Al-Sharafi, 2022). Physics learning is expected to focus not only on students' understanding of the theory but also on the skills to apply physics concepts to solve physics problems in everyday life (Shah, 2019; Yildiz & Guler Yildiz, 2021). Physics has an important role in learning in the era of society applying it (Nuryadi & Widiatmaka, 2023; Cocia, 2020; Cai et al., 2021). In applying physics in the era of society, especially in the social and cultural fields, physics explains many science concepts owned by the surrounding culture (Archer et al., 2020; Avraamidou, 2022; Schaffer & Barreto, 2021). Culture-based physics learning can improve students' cognitive understanding skills and benefit global development (Aisah et al., 2024; Hermawan et al., 2020). Another fact is

that physics learning rarely provides concepts and understanding of the application of physics in the social and cultural fields.

Observations show that students' learning skills are low because physics learning is too difficult. The observation results are reinforced by research by Mufit et al. (2024), which shows that students' concept understanding is still low. According to Gilberti & Organtini (2021), learners have difficulties learning physics due to a lack of proper understanding of natural phenomena. Therefore, physics learning requires factual things that can be seen by students to understand natural phenomena based on physics. One of the strategies to strengthen learners' understanding of physics is to give them a visualization (Faridi et al., 2021; Banda & Nzabahimana, 2021). The observations made by researchers also showed that as many as 51% of students had difficulty understanding due to the lack of visualization in the material being explained. That is reinforced by several studies that students need visualization to understand physics concepts (Nyirahabimana et al., 2023; Barut & Retnawati, 2020). Learning media has an important role in visualizing physics learning, including virtual simulation (Manurung, 2020; Yusuf & Widianingsih, 2020; Yulianci et al., 2021). The observation results state that physics learning still requires virtual simulation. Based on the results of interviews with teachers to improve students' understanding of physics can be done with contextual learning. Through learning with a local wisdom approach, students can understand the application of physics concepts (Waite et al., 2020; J. Bosica et al., 2021; Toharudin et al., 2021). That can be implemented in physics material related to the moment of inertia and angular momentum, which students never know about the application and visualization (Wagg, 2021; Will, 2021). So, it is necessary to develop virtual simulation learning media that integrates local wisdom with the material of the moment of inertia and angular momentum.

One local wisdom that can be integrated with virtual simulation is the traditional game of kekehan (traditional top). This is because the traditional kekehan game has many physics concepts (Deta et al., 2024). Kekehan also has physics concepts including the moment of inertia and angular momentum (Deta et al., 2024). The interview results showed that in the traditional game of Kekehan, there are physics concepts related to the moment of inertia and angular momentum. The uniqueness of local wisdom has the nature of a game, so it is still very relevant when learning is carried out for students (Eliezanatalie & Deta, 2023; Prasetyo et al., 2022). Previous research explains that kekehan is a type of local wisdom that has many physics concepts (Deta et al., 2024; Eliezanatalie & Deta, 2023; Mardiani et al., 2024; Prasetyo et al., 2022). However, little research is still on developing learning media that integrates local wisdom. Many studies have been conducted to attempt to provide visualization of physics concepts, such as virtual simulation (Banda & Nzabahimana, 2021; Georgiou et al., 2021; Holly et al., 2021; Weber & Wilhelm, 2020). Previous research has proven that visualization media such as virtual simulation are still needed. However, there has been no research linking virtual simulation media with integrated local wisdom, one of which is the material of moment of inertia and angular momentum. Therefore, researchers aim to develop virtual simulation media integrated with traditional Kekehan games using materials such as moment of inertia and angular momentum. In addition, developing this virtual simulation is expected to prevent the extinction of local Indonesian culture. Then the questions in this study are as follows:

(1) How is the validity of virtual simulation media integrated with traditional kekehan games?

(2) How is the practicality of virtual simulation media integrated with traditional games of kekehan?

RESEARCH METHOD

Research Design

This research uses the research and development method, with a 3D design (Define, Design, Development, Evaluation). The RnD method is a method to produce products while testing the effectiveness of the products developed (Cahya & Sucahyo, 2021). The picture of the research design carried out is as shown in Figure 1.

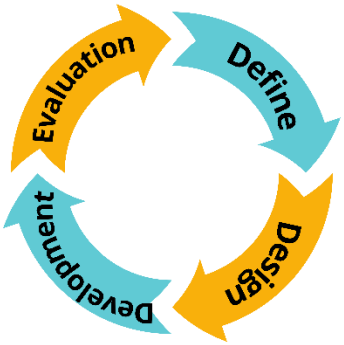

Figure 1. Research design

At the define stage, researchers conducted a case study about students' obstacles in learning physics. At this stage, the researcher observed local wisdom through student questionnaires. At the design stage, the researcher creates a media design that will be developed. The media to be developed is designed to suit actual conditions and physical concepts. Researchers carry out validity test results on expert validators at the development stage according to their field. If the validator's results are rejected, validator's results are rejected, it returns to the initial design stage. After the validation stage in the development stage, researchers conducted limited trials with students to find out their responses. The results of the data obtained from validators to students during limited trials are evaluated. The results of this evaluation are improvements for further research.

Data Collection

The study's sample consisted of students with a limited test of one class (36 students). The instrument given was a validation sheet validated by two validators. Researchers developed a specialization questionnaire related to students' interest in learning media. The indicator variables of the validation sheet to be assessed are attractiveness, media quality, content suitability, and language.

Data Analysis

This research analysis technique uses quantitative analysis. At the development stage, the researcher conducted a validity test with the score criteria obtained as shown in Table 1.

Table 1. Validation Criteria

Percentage (%)	Interpretation Criteria
0-20	Very invalid
21-40	Less valid
41-60	Valid enough
61-80	Valid

Percentage (%)	Interpretation Criteria
81-100	Very valid

(Riduwan & Akdon, 2013)

After conducting a validity test, researchers conducted a limited trial of the learning media developed. The analysis used in the limited trial was an exploratory factor analysis (EFA) by providing a learner response questionnaire (Wang et al., 2024).

RESULTS AND DISCUSSION

Define stage

At this stage, researchers conducted a case study related to physics learning needs of students. The results obtained are represented by Figure 2 in the form of diagrams.

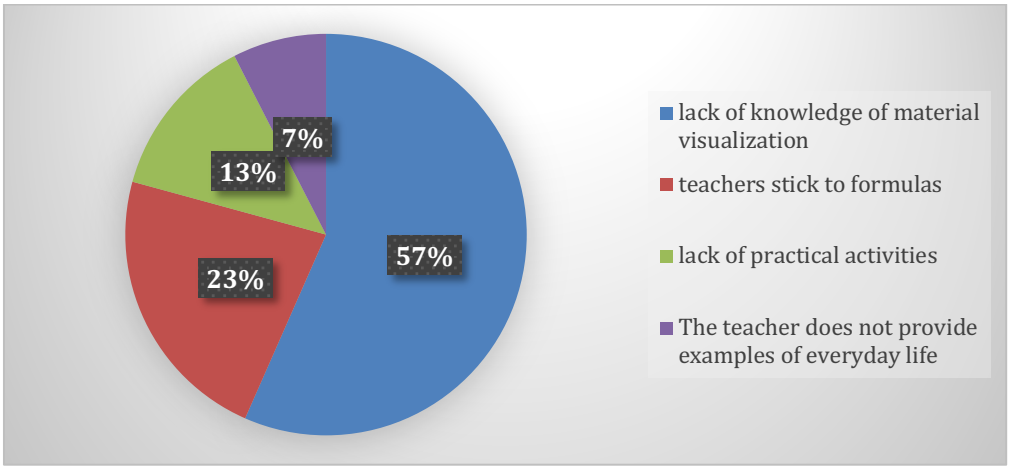

Figure 2. Needs Analysis

The results showed that 57% of students had difficulty learning physics because they did not know how to visualize the material provided. According to Badmus and Jita (2022), providing visualization to students during learning is important to strengthen concepts. In addition, giving contextual phenomenon problems is necessary to process students' skills (Nazifah & Asrizal, 2022; Satriawan et al., 2020; Pursitasari et al., 2020). One example of a phenomenon that can be used as a contextual problem is the phenomenon of local wisdom of traditional games, kekehan. There are many physics concepts owned by kekehan, one of which is the moment of inertia and angular momentum. The fact is that learning media that visualize the concepts of the moment of inertia and angular momentum still does not exist, so further development is needed. So, the researcher wants to develop media that visualizes the concept of the moment of inertia and angular momentum by using the phenomenon of traditional kekehan games.

Design Stage

At this stage the researcher designs the media to be made according to the concept of moment of inertia and angular momentum. The picture of the stage of designing the media to be developed is as shown in Figure 3.

In the design, there are three forms of kekehan in accordance with the characteristics of the East Java region. These three shapes provide visualizations that produce different values of moment of inertia and angular momentum. This is because using the equation

$$I = k.m.r^2 \qquad (1)$$

Where k is a constant object that each shape has its own constant value. In addition, there are other factors if the shape of the object does not match the constant table then the equation

$$I=\int \rho . r^2 dV \qquad (2)$$

Where ρ is the density of the material used and dV is the volume change (Fadlan, 2015). to determine the amount of angular momentum, the equation is

$$L= I . \omega \qquad (3)$$

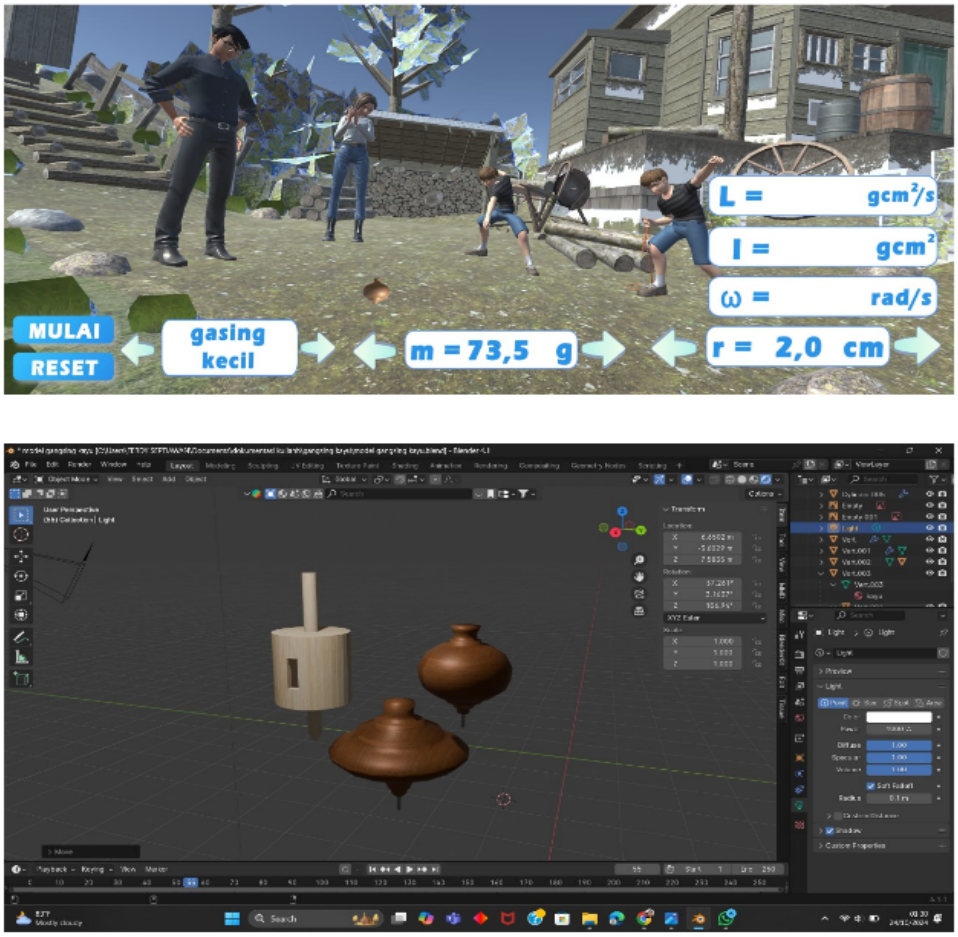

Figure 3. Media Visualization Design

So it can be concluded to give value to the quantities used are ρ,m~I~L the greater the density, radius, and mass, the greater the inertia the greater the angular momentum. In this media case, it is assumed that the object moves in a regular circular motion so that the angular velocity is constant.

Development Stage

At this stage, researchers conducted validity tests on teachers and learning media experts. The validity aspects assessed are attractiveness, content suitability, media quality, and language (Irvani & Warliani, 2022; Mustadi et al., 2022). The validity results obtained by the validity test are as shown in Table 2. The results obtained show that all aspects have very valid criteria. This indicates that the developed media can be used for limited trials on students. This limited trial is used to evaluate the virtual simulation media developed so that it can be further developed and can be generalized (Frederiksen et al., 2020). The

results of validation and limited trials, researchers hope to obtain evaluations for improving virtual simulation media in future research (Coyne et al., 2021).

Table 2. Validation Results

Validity Test				
Aspects	**Validator 1**	**Validator 2**	**Average**	**Criteria**
Attractiveness	88%	94%	91%	Very Valid
Content suitability	100%	83%	92%	Very Valid
Media quality	92%	92%	92%	Very Valid
Language	100%	100%	100%	Very Valid

Evaluation Stage

At this stage the researchers evaluated the results of the virtual simulation media developed. The first evaluation is the result of the evaluation of the validator. The results of the improvement suggestions from the validator are written in Table 3.

Table 3. Validator Suggestions

	Comment
Validator	The animation quality is not in line with physics concepts
	Provide instructions on the use of media
	More creative features to make students interested to learn physics
	Slightly heavy application

Based on the validator's suggestion, the result is to provide motion animation related to the concept of moment of inertia and angular momentum. That is because the media developed only shows the value of the magnitude relationship. However, the concept of visualization of the motion of the moment of inertia and angular momentum has not been seen. That is because visualization must be based on the objectives of the material concept. After all, it will strengthen students' understanding (Lo et al., 2022). In addition, it provides more creative animation features so that students are interested in learning physics. That is relevant to Sastradika et al. 's (2021) research, which found that engaging and creative animation features can increase student motivation.

Evaluation stage on Student's

To answer students' responses, the following shows the data analysis process of the instrument: questionnaire of students' responses to the virtual simulation media integrated with kekehan. Table 4 shows the Kaiser-Meyer-Olkin (KMO) value of 0.593 and the Bartlett's test result is significant ($\chi 2 = 408.021$, df = 105, $p < 0.001$) indicating that the data is suitable for factor analysis (Suprapto, 2019). The eigenvalues of the three proposed factors from Principal Component Analysis (PCA) were all greater than one (Figure 4 and Table 5).

Table 4. KMO Test

Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy.		0.593
Bartlett's Test of Sphericity	Approx. Chi-Square	408.021
	df	105

Sig.	0.000

Table 5. Eigenvalue factors

Component (Factors)	Initial Eigenvalue		
	Total	% of Variance	Cumulative %
1	8.208	54.721	54.721
2	1.966	13.107	67.828
3	1.111	7.404	75.232

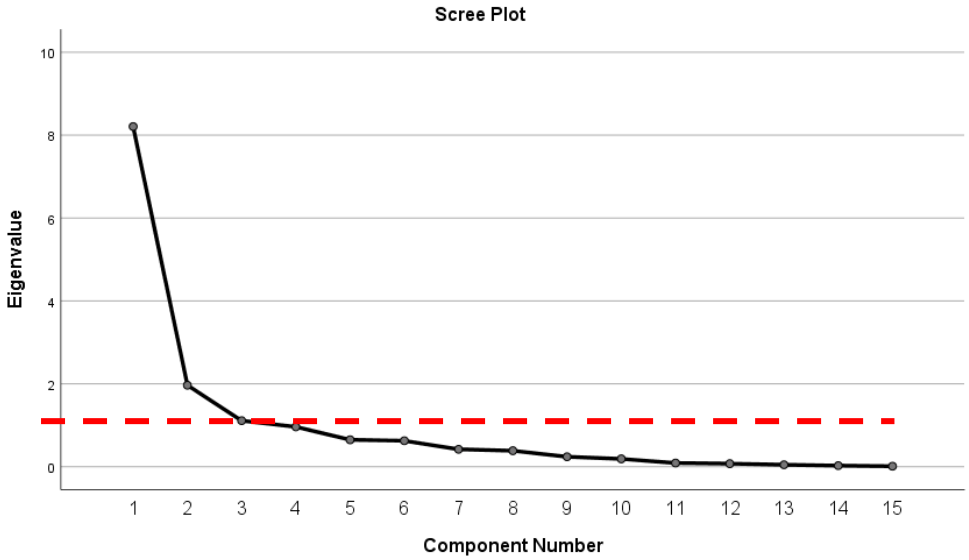

Figure 4. Eigenvalue diagram

The three factors accounted for 75.23% of the total variance. Factor loading of students' responses to the virtual simulation media integrated with kekehan is intended to measure each factor between 0.507 and 0.907. While factor loading less than 0.400 was excluded in the analysis (Suprapto & Ku, 2016; Suprapto, 2019). Cronbach alpha values on three factors are 0.906, 0.870, 0.851, overall Cronbach alpha value is 0.936 as shown in Table 6.

Table 6. Loading Factor

Item	Loading Factors					
	(KM) α = 0.906		(MPF) α = 0.870		(KPM) α = 0.851	
B3	0.876					
D1	0.791					
C2	0.789	30.91% **of Variance Explained**				
D2	0.675					
C1	0.666					
B1	0.616					
B2	0.615					
E3			0.799	24.29% **of Variance Explained**		
E2			0.749			
A3			0.744			
C3			0.722			
A1					0.922	
A2					0.778	

D3	0.739	20.04% **of Variance Explained**
E1	0.595	
Total Variance Explained = **75.23%** and Overall Cronbach Alpha = **0.936**		

Description: KM= Practicality of Media; MPF = Media Helps Physics Problems ; KPM = Interest in Learning with Media

The results of the EFA analysis show that the 15-item questionnaire can be classified into 3 factors, namely KM (Media Practicality), MPF (Media Helps Physics Problems), KPM (Interest in Learning with Media). To analyze further, the factors consisting of indicators are averaged to produce a diagram as shown in Figure 5.

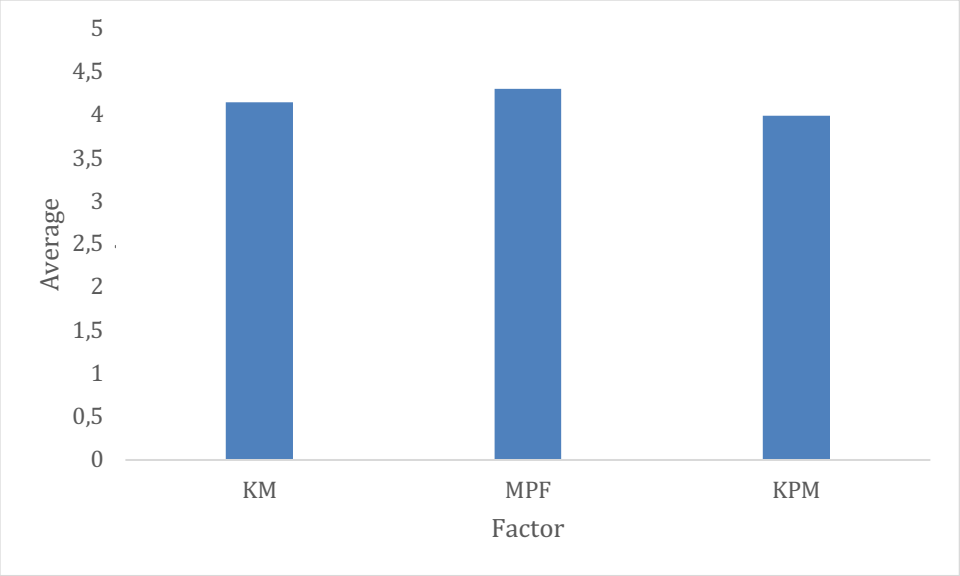

Figure 5. Diagram of Each Factor

Figure 5 shows that the MPF factor is the highest, indicating that the developed media can help in physics problems. The diagram shows that the KPM factor has the lowest average. This is because students are quite interested with the developed media. This is reinforced by table 2 of the validation results that the attractiveness value during the validation process has a low value. The attractiveness value influences students' interest when using it (Agyeiwaah et al., 2022; Harefa, 2023) The results of the evaluation of suggestions from students show that the lack of interesting visualization on the media, so it is hoped that further research can develop virtual simulation media with excellent visualization.

CONCLUSION

Fundamental Finding: The results obtained can be concluded that the virtual simulation media developed get very valid criteria from the aspects of attractiveness, content suitability, media quality, and language. **Implication:** The results of students' responses show that the virtual simulation media developed can be used to help understand physics concepts. **Limitation:** There are several things that must be improved in the development of this media according to the validator, including bringing up animations that are in accordance with the concept of motion of the moment of inertia and angular momentum, so that virtual simulation does not only present the value of the magnitude of the physics concept to be measured. **Future Research:** The shortcomings of virtual simulation media for students are in the visualization of animation on the media, so it needs improvement for further research

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