

Validity Analysis of Virtual Reality Media MENDUA to Improve Students' Cognitive Learning Outcomes

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Abstract

This study is a preliminary study aimed at developing virtual reality technology-based learning media that integrates Javanese culture into Science Physics for High School students. The learning media, MENDUA (Menembus Dimensi Wayang) aims to help students learn Newton's Law by providing a special visualization of the Mahabharata story known as Wayang in Indonesia. This study focuses on the analysis of the validity of the MENDUA learning media by applying the ADDIE research and development method (Analyze, Design, Development, Implementation, and Evaluation). The data collection technique used a validation sheet that is reviewed from six aspects; visual, interest, useful, accurate, legitimate, and structured. The data analysis technique used a Likert scale with a percentage calculation that can be said to be valid or feasible if it meets the validation criteria with a percentage of $\geq 60\%$. The results of the study showed that the validity of the MENDUA media was declared very valid and feasible to be tested by getting a final score of 89.99%. Thus, it can be stated that the MENDUA media is feasible to be used in learning to improve students' cognitive learning outcomes in learning physics on Newton's Law material. This preliminary study highlights the use of VR-based MENDUA is a new way to learn Physics for students. These results are very important for the further development of MENDUA and other VR-based learning media in the future.

Keywords: Learning Media, Virtual Reality, Newton's Laws, Wayang.

Abstrak

Penelitian ini merupakan penelitian pendahuluan yang bertujuan untuk mengembangkan media pembelajaran berbasis teknologi virtual reality yang mengintegrasikan budaya Jawa ke dalam Fisika IPA untuk siswa SMA. Media pembelajaran tersebut, yaitu MENDUA (Menembus Dunia Wayang), bertujuan untuk membantu siswa dalam mempelajari Hukum Newton dengan memberikan visualisasi khusus cerita Mahabharata yang dikenal sebagai Wayang di Indonesia. Penelitian ini berfokus pada analisis validitas media pembelajaran MENDUA dengan menerapkan metode penelitian dan pengembangan ADDIE (Analyze, Design, Development, Implementation, dan Evaluation). Teknik pengumpulan data menggunakan lembar validasi yang ditinjau dari enam aspek, yakni *visual*, *interest*, *useful*, *accurate*, *legitimate*, dan *structured*. Teknik analisis data menggunakan skala likert dengan perhitungan persentase yang dapat dikatakan valid atau layak apabila memenuhi kriteria validasi dengan persentase $\geq 60\%$. Hasil penelitian menunjukkan bahwa, kevalidan media MENDUA dinyatakan sangat valid dan layak untuk di uji cobakan dengan mendapatkan skor akhir 89,99%. Sehingga, dapat dinyatakan bahwa media MENDUA layak untuk digunakan dalam pembelajaran untuk meningkatkan hasil belajar kognitif peserta didik dalam pembelajaran fisika materi Hukum Newton. Penelitian pendahuluan ini menyoroti bahwa penggunaan MENDUA berbasis VR merupakan cara baru untuk mempelajari Fisika bagi siswa. Hasil ini sangat penting untuk langkah pengembangan MENDUA selanjutnya dan media pembelajaran berbasis VR lainnya di masa mendatang.

Kata kunci: Media Pembelajaran, *Virtual Reality*, Hukum Newton, Wayang.

INTRODUCTION

Education is considered the most important thing in every country. However, currently the quality of education in Indonesia is considered still low based on the level of student learning outcomes (Suncaka, 2023). The results of observations conducted during the PLP program showed that in learning Newton's Law, students often had difficulty in understanding and remembering the material they learned. This is in line with research conducted by Fadlli, many students still have difficulty in understanding

the physical concept of Newton's First Law and tend to only memorize the formula. In addition, students are also still lacking in analyzing the forces acting on an object properly. Also, there is a misunderstanding that the mass of an object affects action-reaction and students also still have difficulty applying the action-reaction force between two objects in the context of everyday life (Fadlli et al. 2019).

The difficulties experienced by students are influenced by the idea that physics learning is difficult to

understand and boring to learn, which affects students' learning motivation and learning outcomes. If teachers able to create an interesting learning atmosphere so that students feel motivated, this will improve students' learning outcomes (Supriadi & Hignasari, 2019). Physics is a subject that not only contains theories and formulas to be memorized, but places more emphasis on understanding and comprehension of concepts obtained from the process of forming knowledge through discovery and data analysis (Kusdiastuti et al., 2019).

Learning media is a tool used and supports the learning process to be more effective and optimal. The development of technology-based learning media can increase efficiency and effectiveness in learning. One of the technology-based media that is currently trending is Virtual Reality (VR). VR technology is a three-dimensional (3D) animation technology to interact virtually with a computer-simulated environment so that users can feel the real sensation and can be interacted in it (Nurriqza et al., 2021). The use of Virtual Reality in the learning process can increase students' enthusiasm for learning. Virtual Reality has an attractive packaging to stimulate students' curiosity, reduce boredom in the learning process, and because it is based on real-life situations, so students can understand learning materials faster. (Arsadhana et al. 2022).

The development of technology based on Virtual Reality (VR) is very useful and has a big influence on human life. As in the example of the use of technology based on Virtual Reality used in Physics learning at the high school level. Physics is a difficult lesson, since physics learning is less interesting for students and also the teaching delivered does not build the concept of physics in students (Setiaji et al., 2023). Therefore, utilizing Virtual Reality (VR) as one of the teaching media, it can stimulate thought patterns and build abstract concepts in students, since Virtual Reality (VR) technology can visualize abstract concepts for understanding (Wardoyo, 2023). This is in accordance with Makransky & Petersen (2021) which states that VR allows students to interact with concepts that are difficult to understand in the real world, which has a positive impact on learning interest and motivation.

Technological developments have an impact on the world of education. Integrating technology into education can influence students to learn actively and increase their interest and motivation in learning (Ghofur & Youhanita, 2020). This is in line with the learning style of Gen Z students who are faster, more independent, prefer audiovisual formats, and are technology-based (Hashim, 2018). Thus, the development of this technology is a challenge for teachers to be able to create an innovative learning process (Alkhatabi, 2017). Thus, teachers are

currently required to have educational content creation skills, meaning teachers must have the ability to create digital learning content such as innovative learning applications, interactive presentations, and learning animations (Blyznyuk, 2019).

Rapid globalization is one of the causes of the decline in local cultural values in Indonesia, which causes a shift in cultural values and local wisdom (Vitry & Syamsir, 2024). Currently, the role of educators is very important to find local wisdom values and can integrate them into the learning process. The learning process can be a form of means in an effort to empower human potential to inherit, develop and build civilization in the future. One effort that can be made to build civilization is to increase understanding of the surrounding environment, especially those related to culture as a legacy of ancestors (Darmawan et al., 2023).

One of the local wisdoms in Indonesia that must be preserved is wayang kulit. Wayang is one of the traditional arts that grew and developed especially in Javanese society and has a strong philosophical meaning. Each wayang script has a different form depending on the characteristics of the characters owned by the wayang script (Tiyas, 2022). Wayang are used to bring characters to life in traditional theater performances performed by dalang (puppeteers) (Sumaryanti, 2018). Although UNESCO has recognized wayang as Indonesian culture, on several occasions, Malaysia has included wayang kulit as one of the cultural attractions in its tourism (Amir et al., 2023). Therefore, the young generation of the Indonesian nation must maintain the cultural heritage so that it remains Indonesian culture and is not claimed by other countries. Wayang has several advantages as a medium for instilling character values. So that wayang kulit can be used as a learning medium to form morality and moral development for the younger generation.

Based on these problems and the results of observations that have been made, researchers developed Virtual Reality-based teaching media by implementing a three-dimensional display entitled "Development of Virtual Reality Media MENDUA (Menembus Dimensi Wayang) to Improve Students' Cognitive Learning Outcomes on Newton's Law Material" which can help students understand physics learning materials in detail with an attractive display so that it can make students improve cognitive learning outcomes. This research presents innovation in the development of physics learning media through the use of Virtual Reality (VR) technology specifically designed to teach the concept of Newton's Law with a cultural approach, namely the Wayang theme. Previously, the use of VR technology in physics education was still limited to general visualization without

considering the integration of local cultural aspects that are relevant to character education values. This study aims to develop VR-based learning media to teach Newton's Law with a Wayang theme whose feasibility has been validated.

METHOD

This study uses Research and Development (RnD) study that aims to develop Virtual Reality (VR) technology-based learning media that integrates local culture into Newton's Law physics learning materials. The Development Research Method uses the ADDIE model which is adjusted to the focus and objectives of this Research. The ADDIE stages used are limited to the analysis, design, and development stages. Meanwhile, Implementation and evaluation that integrate certain learning models will be designed after the Media has been validated for its feasibility and is ready to be tested in a learning setting. The flow diagram of this research can be seen in Figure 1.

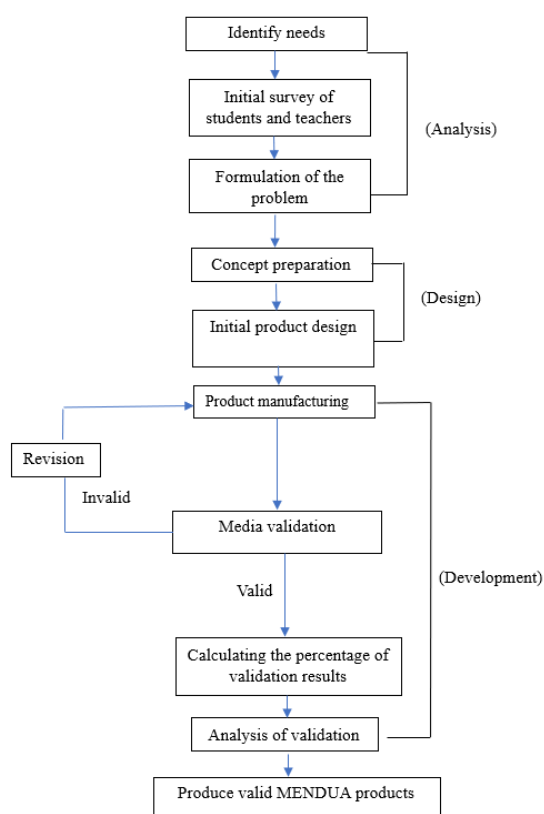


Figure 1. Research Flow Scheme

The first stage of analysis is to identify needs, where the analysis is carried out on the needs of students and teachers through an initial survey. The results of this survey are used to formulate the problem that is the basis of the research. The second stage is design by determining the media concept which begins with the creation of a storyboard which functions to facilitate the development process. At this stage, an initial design is also made as a

proposed prototype. The third stage is development, developing a learning media from the storyboard that has been made so that the media is in accordance with the planning that has been prepared in the previous stage, then validation is carried out so that the media is feasible and ready to be tested in limited learning.

Data collection technique

The data collection technique used a validation sheet filled out by three media and physics learning experts. This instrument is in the form of an assessment sheet on the quality of the feasibility of MENDUA learning media on Newton's Law material based on local wisdom of wayang which is useful for improving the learning media that has been designed and will be used for the trial stage.

Data Analysis Techniques

This study uses quantitative data analysis from the validation results of MENDUA learning media. This analysis is arranged based on a Likert scale. The assessment criteria for validation are shown in Table 1.

Table 1. Answer System with Likert Scale

Score	Answer
4	Very Valid
3	Valid
2	Quite Valid
1	Invalid

(Sugiyono, 2018)

The scores obtained are then totaled, the percentage of implementation is calculated using the equation:

$$NV = \frac{\sum x}{\sum x_t} \times 100\% \quad (1)$$

Information:

NV= Validation Value

$\sum x$ = Sum of scores obtained by an item

$\sum x_t$ = Maximum score sum

The criteria are as in table 2.

Table 2. Validation Criteria

Presentation	Information
0% - 20%	Very Invalid
21% - 40%	Invalid
41% - 60%	Quite Valid
61% - 80%	Valid
81% - 100%	Very Valid

(Sugiyono, 2018)

The learning tools and media developed can be said to be valid/good/suitable if they meet the validation criteria with a percentage of $\geq 60\%$ (Sugiyono, 2018).

RESULT AND DISCUSSION

The results of this study are in the form of MENDUA (Menembus Dimensi Wayang) media to help the learning process of Newton's Law of Physics material in high school. The following are the results of each stage of the ADDIE model from analysis to development in this study:

Analysis

The analysis stage is the initial step to collect data in development research. Data is collected from the results of observations, interviews, and documentation conducted when the research team implemented the School Field Introduction program. At this stage, it begins by analyzing the curriculum used in schools. The curriculum used is the independent curriculum, in this case focused on the physics subject phase F. The independent curriculum Phase F for class XI contains material on kinematics and dynamics of particle motion which includes Newton's Laws (Ministry of Education and Culture, 2022).

The next stage of analysis is to analyze the understanding and character of students. Based on the results of observations made, there are still many students who do not understand the material on Newton's Laws that should have been studied at the junior high school level. This is because the learning process during junior high school is carried out online, so that understanding of the basic concepts of Newton's Laws has not been optimally formed. In fact, this material is the basis of various other physics concepts. In addition, students often have difficulty understanding and remembering the material they have just learned.

Analysis of student character shows that students show a tendency as visual and kinesthetic learners, are more interested in technology and digital media, consider physics learning to be difficult and boring. By considering this analysis, the researcher developed the Virtual Reality MENDUA (Through the Wayang Dimension) media to help learning Newton's Law integrated with wayang. Wayang was chosen with the consideration of preserving Indonesian Culture which is almost fading.

Design

The creation of MENDUA learning media uses the help of the Millealab Creator application to combine various elements, such as images, text, audio, video and 3D objects, into one complete and interactive media unit. The name MENDUA is an acronym for Through Wayang Dimensions. The choice of the name MENDUA is not intended to lead to negative connotations such as having an affairs, but rather reflects the diversity of perspectives in the learning process. This name suggests that students are not only invited to think scientifically in physics

learning, but are also invited to understand the richness of local culture.

MENDUA learning media is conceptualized in the form of an interactive museum. The inspiration for the concept came from a visit to the MPU Tantular museum located in the Sidoarjo area, where researchers were inspired after seeing the cultural heritage of Indonesia which was then presented with technological developments that contained a lot of physics learning.

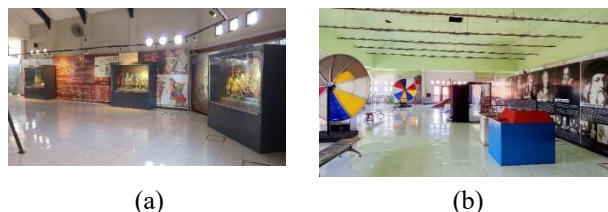


Figure 2 Documentation of Visit to MPU Tantular Museum (a) History of shadow Wayang (b) World developments containing physics material

This VR-based MENDUA media consists of 2 scenes, the first scene where students learn about the world of puppetry and the second scene students learn about Newton's Law integrated with puppetry. There are 31 stand points and 2 quizzes, in addition to the quizzes students are also given case studies that will be completed with their groups outside the Virtual Reality world. The following is the concept or initial design of the VR-based MENDUA media display integrated with puppetry. The concept or initial design of the two scenes can be seen in Figure 3.

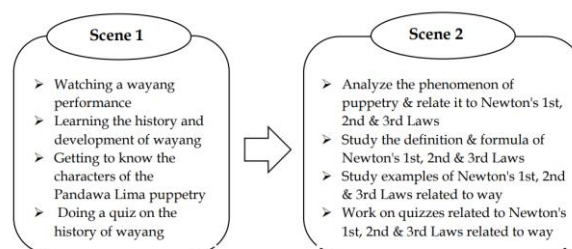


Figure 3 MENDUA Media Initial Design Concept

The initial design that has been prepared is then changed into a storyboard so that the media development process is more systematic and reduces the potential for errors in the development process.

Development

The production or manufacturing stage is carried out by researchers by referring to the results of the analysis and design that have been carried out in the previous stage. The development of MENDUA learning media begins

with compiling the creation of a museum according to the previous concept, then compiling the appropriate elements. After the museum is finished, they start making images through Canva and videos through Capcut to make it easier for students to understand the material in the museum. The results of the development of MENDUA learning media are as follows.

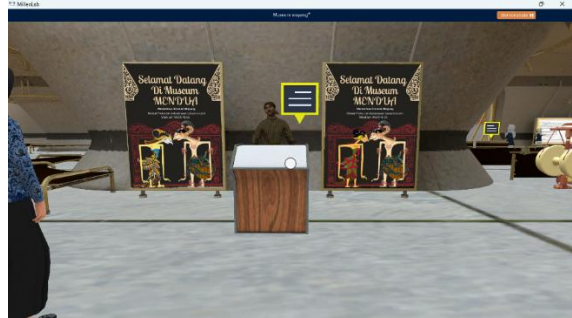


Figure 4 MENDUA Media Production Results Accessed Non-Gyro

After the media is finished, then continue to the validation stage. The validation stage aims to assess the feasibility of the media before it is carried out to the trial stage. The level of validity of the MENDUA media was tested with a validation process by three experts. In this study, validation was carried out on media expert lecturers, physics expert lecturers and physics teachers who had developed VR media. Validation of the MENDUA media includes visual, interest, useful, accurate, legitimate, and structured aspects. The six aspects have different scores from the validators which are presented in the following graph.

Table 3. MENDUA Media Validation Results

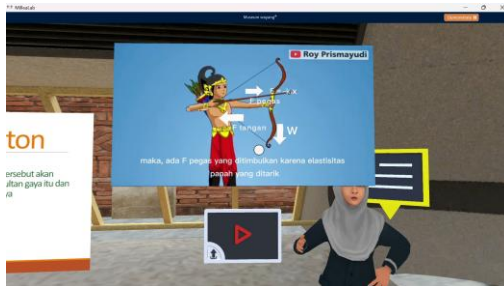
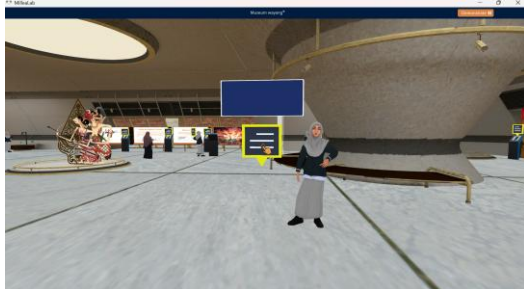
Aspect	Score (%)			Average (%)
	V1	V2	V3	
Visual	93.75	93.75	81.25	89.58
Interest	91.6	91.6	83.3	88.83
Useful	91.6	91.6	83.3	88.83
Accurate	91.6	91.6	91.6	91.6
Legitimate	87.5	93.75	81.25	87.5
Structured	87.5	93.75	81.25	87.5
Final Score (%)				88.97

The results of the validation of learning devices that have been assessed by 3 validators, show that the MENDUA media is declared very valid or very feasible to use with a final score of 88.97%. The highest score is in the accuracy aspect with a final score of 91.6% and the lowest score is in the validity and structure aspects with the same score of 87.5%.

Based on the assessment by the validator and the discussion studied, it can be concluded that the MENDUA media is included in the very valid category and can be used for the media trial stage. After validation by the validators, assessments and inputs were obtained in the form of reviews of the developed media. The results of the review were then used as a basis for making revisions in accordance with the direction and input given by the validator. The parts that need to be revised are included in the following table.

Table 4. Revisions from the validator and follow-up actions

No	Review Results	Follow-up
TWO Media Revision		
1.	The formulas in Newton's Laws need to be harmonized so that they refer to one consistent source.	Adjust all formulas to one reference using Giancoli's 2014 physics book source.
2.	Reviewing the sample questions used in the media.	The sample questions have been reviewed and adjusted to actual reality.

No	Review Results	Follow-up
		
3.	The description of phenomena in wayang using Newton's Law needs to be explained in more detail, especially regarding the direction of the force at work. 	The video has been improved, with the style direction now being explained more clearly. 
4.	There are several information boxes that do not have additional captions, but can be given a short caption in the form of a conclusion. 	Information boxes that previously had no captions are now equipped with captions to make the information easier to understand. 

Based on the validation results in table 3, it shows that the media validation results in each aspect get different scores, but the range is not too far and all get a very valid category. The validation results in each aspect will be discussed in more detail in the following description.

1) Visual

The appearance aspect is an inseparable part of developing a media (Zakaria & Anggaryani, 2024). The appearance aspect of a media influences users to explore the media, which can be assessed through the sense of sight. In this aspect, the clarity of the VR display is assessed when accessed using a VR device (VR glasses) or using a smartphone directly (Sukirman et al., 2019). In addition, elements such as text, images and videos in the media must also be clearly visible and

readable to make it easier for students to understand the contents of the media (Dewi & Handayani, 2021).

The assessment from the validator for this aspect is 89.58% which is included in the very valid category. Based on suggestions and input from the validator, there are videos that are not optimal in size in the media so that they are not clear to see. This is due to the need to adjust the position when browsing the media and the placement of the standpoint is not right. The follow-up to this is to enlarge the size of the video so that it is easy to see and clear and adjust the position of the standpoint so that it is easy and in a comfortable position to watch the video presented. After the revision, the video can be clearer and more comfortable to see.

2) Interest

The aspect of attracting students' attention received a final score from the validators of 88.83% which is included in the very valid category. Boring physics learning requires a media that can attract students to be enthusiastic in participating in learning (Ismiyanti, 2020). So, by attracting a media, it can increase student participation in participating in learning. In this aspect, what is assessed is the environmental design of the media, the animation of the media and how the storyline is in the media.

Based on the assessment of the validators, the MENDUA media is able to attract the attention of students during learning. The environmental design used in the MENDUA media is a museum environment, so that students are made to feel like they are exploring a museum to get Newton's Law material that is integrated with puppet stories and learning about Indonesian culture. However, there are validators who suggest that the animation used does not reflect the physics content. The follow-up is done by adding several physics animations, especially Newton's Law in the MENDUA media.

3) Useful

The development of a media is not only focused on its appearance and attractiveness during creation, but also on whether the media can be useful or not. Thus, the aspect of usefulness or function of a media needs to be validated by the validator. The practical function of the media has been described in the previous chapter, that the media must be able to be an intermediary for the process of exchanging information with students. In this aspect, the final score from the validators was 88.3%, which is included in the very valid category. Thus, the MENDUA media can be said to be an intermediary for conveying Newton's Law material to students. This can be proven by an increase in cognitive learning outcomes in students. According to research conducted by Mubarak & Anugrah (2024), VR media can be an intermediary for teachers to deliver learning materials well.

4) Accurate

The accuracy aspect received a final score from the validators of 91.6% which is included in the very valid category. The accuracy of a media means that the media must be in accordance with the predetermined learning outcomes, the objects in the media can present physics concepts and the media can convey the message that is to be conveyed clearly (Dermawan, 2024). Based on the validator's assessment, this MENDUA media was declared accurate and in accordance with the planned design with a valid category. The validator also provided suggestions that

the examples of phenomena used in the media need to be adjusted again to comply with Newton's Law explained. The follow-up that was carried out, the existing phenomena have been adjusted to the concept of Newton's Law according to the suggestions of the validator.

5) Legitimate

The validity aspect received a final score from the validators of 87.5% which is included in the very valid category. This aspect shows that the use of 3D objects in MENDUA media has presented real objects like in the real world by considering the ratio in the virtual world. The choice of colors in the media is also aligned so that when students explore the MENDUA museum they feel comfortable and do not experience disturbances in the visual aspect. In addition, the arrangement of 3D objects is designed to suit the place and function so that users are not disturbed by the presence of 3D objects and learning becomes more effective (Hapsari, 2022).

6) Structured

The structural aspect received a final score from the validators of 87.5% which is included in the very valid category. The structure of a media is very important, especially in VR media because students need to explore the VR world. If the media is not structured neatly and clearly, it is feared that students will be constrained and have difficulty in exploring the VR world of MENDUA. In this aspect, what is assessed is the media navigation system, clarity of instructions, having a guide to using the media and the media has a flow that is in accordance with learning objectives.

Navigation in this VR-based MENDUA media is assisted by the presence of standpoints that require students to follow the path of the existing standpoints. In addition, at each point there is a guide who will direct students to do what to do next so that students are not confused during the process of exploring the MENDUA museum. This MENDUA media is also equipped with a user guidebook that has also been validated and received a final validation score of 97.20% which is included in the very valid category and can help students in accessing and exploring the MENDUA museum. The flow used in the MENDUA media is also adjusted to the predetermined learning objectives and in accordance with the existing cognitive level.

Based on the assessment by the validator and the discussion studied, it can be concluded that the MENDUA media is included in the very valid category and can be used for the media trial stage. Although there are

suggestions and input from the validator for the media, the media has been improved according to the validator's suggestions and input. These results are reinforced by previous studies that are in line with this study. Several studies were conducted by Prillyanti & Anggaryani (2023), Pambayun (2024), Styadi & Istiyowti (2025) and Zakaria & Anggaryani (2024), the study stated that Virtual Reality-based media is suitable for use in learning with a very valid category obtained from the assessment by the validator.

CONCLUSION

The conclusion obtained from the results of the study based on the results of the validation of the learning devices that have been assessed by 3 validators, shows that the MENDUA media is declared very valid or very feasible to use with a final score of 88.97%. Thus, the MENDUA learning media is feasible to use to improve students' cognitive learning outcomes in the material of Newton's Law integrated with local wayang wisdom. The results of this study are expected to be a new reference for teachers in integrating Virtual Reality (VR)-based learning media into physics learning in schools. The limitations of this study are inadequate facilities and infrastructure to access VR and limited budget for the procurement of VR devices in large quantities, so that students have a little difficulty in accessing the MENDUA media. Suggestions for further research can ensure that schools and students are ready for the implementation of VR media and can continue to evaluate the effectiveness of using VR media in depth.

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