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Development of History-Based Animated Video Learning Media on Archimedes' Law Material

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ABSTRACT
This study aims to develop learning media in the form of history-based animated videos on Archimedes' principle and to test its feasibility and effectiveness in supporting the physics learning process. The research method used is the 4D development model, which includes the stages of define, design, develop, and disseminate. The subjects in this study involved 37 students from Labschool Untad Palu High School. The research instruments included validation sheets for media experts, subject matter experts, and practitioner experts, as well as student response questionnaires. The validation results showed that the developed learning media received a rating of Very Good from all experts, indicating that the media was suitable for use in learning. Trials with students on a limited and large scale also showed positive responses with a rating of Good. Based on these results, it can be concluded that the history-based animated video media on Archimedes' Principle material is deemed feasible and can be used as a supporting tool in physics learning activities.

INTRODUCTION

Learning media plays a very important role in helping the effectiveness of the learning process. As the main tool, learning media functions to help teachers deliver material in a more structured and easily understood way by students [1]. Along with the rapid development of information and communication technology, the education system in Indonesia has also undergone significant changes towards the era of digitalization [2] These changes have encouraged the need to integrate technology into learning media to bring about innovations that are more interesting and relevant to the characteristics of today's digital generation [3].

Physics is one of the subjects that is often considered challenging by students because the material is abstract and requires a deep conceptual understanding [4]. The nature of Natural Science as a science that originates from nature and has several abstract concepts that cannot be presented directly into the classroom is a challenge for teachers to convey these concepts [5]. Advances in technology require teachers to keep up with technological developments in the teaching and learning process. Until now, teachers have used books and online media such as PowerPoint as learning media, which sometimes makes it difficult for teachers and students to access, receive and provide information. One use of information technology in learning is the use of videos as a tool to visualise abstract concepts [6]. Not all students have good imaginative abilities in understanding physics concepts in depth. Therefore, the use of technology-based learning media such as animated videos can be an effective alternative to overcome these limitations [7].

Educational videos are a form of audio-visual media that serve to convey learning messages in order to achieve predetermined competencies [8]. Videos are teaching materials that can be seen and heard simultaneously. The main element in learning using video media lies in the learning outcomes obtained through more concrete learning experiences. This is because audio-visual-based learning involves not only hearing through words, but also seeing through moving images that are more realistic [9]. According to Kurniasari animations accompanied by learning instructions can help visualise abstract concepts more clearly, thereby fostering learners' motivation to learn. Animated videos not only serve as a supplement to learning information, but also increase students' interest in learning [3]. This media displays objects or images that move sequentially accompanied by sound effects, resulting in a complete multimedia presentation [10].

According to Berliana and Subali the use of video media in learning can increase students' interest in learning, especially in experimental classes that use video as the main media. This increase occurs because students feel more interested and enthusiastic about visual displays that are attractive and not monotonous [11]. The results of research conducted by Ikhsanudin also reveal that the development of animated video media has proven to be effective in learning activities. This effectiveness is based on the N-Gain test results, which reached 62.5% and is classified as moderate [12]. Previous studies have shown that animated video-based learning media have great potential in improving learning effectiveness, including in vocational fields. A study on basic electrical engineering subjects in vocational secondary schools developed animated video-based learning media to overcome teachers' difficulties in achieving optimal learning outcomes in online learning. The study proved that the animated media developed was highly suitable for use, as demonstrated by the validity test results by subject matter experts with scores of 90–92% and media experts with scores of 91–100%. In addition, a practicality test involving subject teachers obtained a score of 86–93%, which means that the media is easy to use and aids the learning process. These findings reinforce that the use of animated videos can provide significant support in improving student understanding and making it easier for teachers to deliver abstract and technical material [13]. Research conducted by Fahra shows that E-MASL learning media, in the form of animated videos, is based on multimodal representations oriented toward Ethno-STEM. The representations used include text, sound, images, video, and animation, which aim to facilitate students' understanding of science learning concepts. This way, students can understand that science learning can be found in real life [14].

One innovative approach in the development of physics learning media is to integrate historical elements. The use of historical elements in learning has been proven to attract students' interest and help them understand physics concepts through contexts that are close to their lives. Previous research on Tongkonan traditional houses, for example, shows that traditional cultural objects can be used as sources for physics learning because they contain various concepts such as density, elasticity, equilibrium of rigid bodies, rotational dynamics, and pressure. These findings show that physics learning becomes more meaningful when linked to cultural and historical aspects. This is in line with the need to develop physics learning media that not only convey concepts abstractly, but also present them in a concrete historical context [15]. In the Archimedes' law material, a history-based approach is very important because the concepts of upward force and the principle of buoyancy were originally formulated through the historical events of Archimedes' discovery. The development of history-based animated video learning media on this material can help students understand the concept through the storyline of the discovery, increase learning motivation, and foster a deep understanding through interesting and memorable historical narratives.

Based on research conducted by Lusiana et al. (2024), 65% of students stated that Archimedes' principle was difficult material. This was based on the students' responses, which stated that Archimedes' principle had abstract concepts that were difficult for them to understand. In addition, the lack of visualisations or animations to explain the concept of buoyancy made it even more difficult for them to imagine the process. In line with the results of interviews conducted with physics teachers at Labschool UNTAD Palu High School, it is known that students still have difficulty understanding the concept of Archimedes' principle, especially in terms of using formulas, determining buoyant force, and the condition of objects when immersed in fluid. Furthermore, students also admitted to having difficulty understanding the origin of the variables in the formula, so they only memorised it without understanding the physical meaning behind the formula. This shows the need for learning media that can visualise these concepts clearly, concretely, and contextually [16].

Based on the above description, innovation in physics learning is needed through the development of animation-based media that meets the demands of the digital age. Although the use of video as a learning medium has been widely implemented, interactive media in the form of animated videos that contain historical elements are still rarely developed. Therefore, the development of history-based animated video learning media is very important and relevant today. This media is expected to not only help students understand physics concepts more concretely, but also foster interest, curiosity, and appreciation for the scientific process and the history of scientific development.

METHOD

This research was conducted using the research and development method. It employed the 4D development model (Define, Design, Develop, and Disseminate). This model was chosen because it is suitable for developing educational products that are systematic and have been tested for feasibility before being disseminated [17].

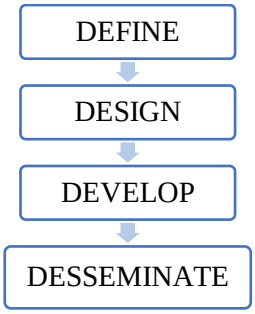

Figure 1. Model 4D

In the define stage, media development needs were identified through observation, interviews with physics teachers, review of teaching modules, and literature studies. These activities included preliminary analysis to determine learning conditions and obstacles in delivering material, task analysis to map competency achievements and material scope, and concept analysis to systematically structure material by integrating elements of the history of Archimedes' Law. Next is the design stage, which involves designing a media prototype through the preparation of a storyboard, graphic design, animation, and audio, as well as the preparation of research instruments in the form of expert validation sheets and student response questionnaires. This stage produces a preliminary design for a learning video that is ready for development. The develop stage includes media production and a validation process by subject matter experts, media experts, and practitioners, followed by revisions based on feedback. Next, a limited trial was conducted with 7 students and a large group trial with 30 grade XI students at Labschool Untad Palu High School to assess the feasibility and student response to the developed media. The Disseminate stage was carried out after the product was declared feasible based on the validation and trial results. The product was disseminated through digital media such as YouTube so that it could be widely accessed and support the physics learning process, especially the Archimedes' Law material.

Figure 2. Animated video learning media

The data analysis technique in this study uses a quantitative and qualitative descriptive approach. Qualitative descriptive analysis is used to process data in the form of comments, suggestions, and responses from experts and students obtained through the validation and testing process. This qualitative data was analysed by examining each input to identify aspects that needed to be improved or enhanced in the learning media. The results of this analysis were used as the basis for revising the product until a suitable medium that met learning needs was obtained. Meanwhile, quantitative descriptive analysis was used to process data from the validation of media experts, subject matter experts, practitioners, and student responses to the developed learning media. The data

obtained through the Likert scale assessment sheet is averaged and then converted into a percentage to determine the media's suitability category.

Table 1. Likert scale

Description	Score
Very Good	5
Good	4
Fairly Good	3
Not Very Good	2
Very Poor	1

By calculating the total score for each assessment aspect, the following formula is used.

$$\bar{x} = \frac{\sum x}{N} \quad \ldots (1)$$

Explanation:
$\bar{x}$ = Average assessment score
$\sum x$ = Total score obtained
N = Number of statements
The average score for each aspect is then converted into a 5-point scale score, as listed in Table 2.

Table 2. Convert scores to a 5-point scale

Formula	**Score**	**Criteria**
$\bar{X}_i + 1{,}8\ Sbi < X$	$4{,}21 \leq 5{,}00$	Very Good
$\bar{X}_i + 0{,}6\ Sbi < X \leq \bar{X}_i + 1{,}8\ Sbi$	$3{,}41 \leq 4{,}20$	Good
$\bar{X}_i - 0{,}6\ Sbi < X \leq \bar{X}_i + 0{,}6\ c$	$2{,}61 \leq 3{,}40$	Fairly Good
$\bar{X}_i - 1{,}8\ Sbi < X \leq \bar{X}_i - 0{,}6\ Sbi$	$1{,}81 \leq 2{,}60$	Not Very Good
$X < \overline{X_i} - 1{,}8\ Sbi$	$X \leq 1{,}80$	Very Poor

RESULTS AND DISCUSSIONS

Based on validation assessments by media experts, subject matter experts and practitioners, the following results were obtained.

Table 3. Media Expert Validation Results

Aspect	Average Score	Criteria
Software Engineering	4.29	Very Good
Learning Design	4.50	Very Good
Visual Communication	4.38	Very Good
Overall Average Score	4.39	Very Good

Expert validation of the media was conducted based on three main aspects, namely software engineering, learning design, and visual communication, with a total of 23 assessment items. The assessment results showed that the media obtained an overall average score of 4.39 in the Excellent category. In terms of software engineering (4.29), the media was considered effective, easy to use, compatible, and suitable for the development device. The learning design aspect received the highest score (4.50), indicating that the presentation of sub-material and transitions between materials were systematic and clear. Meanwhile, the visual communication aspect (4.38) showed that the video display was attractive, contextual, and able to motivate students in understanding the material. Thus, the media was declared suitable for use in the next stage of development testing.

Table 4. Material Expert Assessment Results

Aspect	Average Score	Criteria
Substance of Material	4.43	Very Good
Language	4.67	Very Good
Overall Average Score	4.55	Very Good

Expert validation of the material covered two main aspects with a total of 10 assessment items, namely material substance and language. The validation results showed an overall average score of 4.55, which falls into the Very Good category. In terms of material substance (4.43), the assessment focused on the systematic presentation and clarity of the Archimedes' principle material. These results indicate that the content of the material is logically structured, in line with the learning outcomes, and easy for students to understand. Meanwhile, the linguistic aspect received a score of 4.67, indicating that the sentences in the video narration are clearly structured, communicative, and in accordance with the rules of good and correct Indonesian. Overall, these results indicate that the content and language in the learning media meet the eligibility criteria.

Table 5. Practitioner Expert Assessment Results

Aspect	Average Score	Criteria
Substance of Material	4.88	Very Good
Language	4.67	Very Good
Software Engineering	5.00	Very Good
Visual Communication	4.73	Very Good
Overall Average Score	4.82	Very Good

Based on the data in Table 5, the validation results conducted by expert practitioners show that the learning media obtained an overall average score of 4.82 and was classified as Very Good. In terms of material substance, the media received an average score of 4.88. Meanwhile, in terms of language, it received an average score of 4.67, which is also classified as Very Good. The software engineering aspect showed maximum results with a perfect score of 5.00, and in terms of visual communication, the media achieved an average score of 4.73, which is classified as Very Good.

Table 6. Development Trial Results

Test Type	Average Score	Criteria
Limited Trial	4.06	Good
Large Group Trial	4.11	Good

A limited trial was conducted on seven students from grades XI MIA 1 to XI MIA 3 at the school where the research took place. The sample selection was based on the recommendations of subject teachers, considering that these students had good academic abilities and were deemed capable of providing objective assessments of the learning media. Based on the results in Table 5, the average overall score of the students' responses was 4.06, which falls into the Good category.

The history-based animated video learning media on Archimedes' Principle was developed as a tool to assist teachers and students in learning activities. This video serves as an attractive and communicative medium for delivering material. By combining visual and audio elements, this media makes it easier for students to visualise abstract physics concepts, thereby helping them to better understand and remember the material being studied.

In practice, teachers can use this video to support the delivery of Archimedes' principle material in class. One of the advantages of this media is that its content structure is organised into four sub-topics, helping teachers to teach the material in a clear and systematic manner. At the beginning of the video, an example of the application of Archimedes' principle in everyday life is shown in the form of a ship that can float on the surface of the water. This footage can be used as a stimulus for teachers to ask provoking questions to encourage critical thinking among students. Next, the video introduces Archimedes as the scientist who discovered this law. Thus, students not only learn the scientific concept but also get to know the important figure behind the discovery, making the learning more contextual and inspiring. According to Farida [18] animated videos are a form of innovation in the use of multimedia technology for learning. Compared to static media such as images or text, animations have the advantage of conveying processes or changes that occur over time. This is very effective for explaining the stages or procedures of an event more clearly and interestingly.

The main characteristic of this media lies in the narration of the history of the discovery of the law, which is conveyed narratively through animation. This presentation proved to be effective in focusing the students' attention on the show, and even elicited enthusiastic responses from several students who showed curiosity. Some students appeared curious, and several others spontaneously stated that physics, which had always been considered difficult, also had an interesting historical background. This shows that incorporating historical aspects into learning media can build students' emotional engagement while strengthening their understanding of the concepts being taught.

Another study by Aditya [19] also suggests that history-based learning media is an important requirement in the modern learning process. International research [20] shows that integrating the history of science into physics teaching has a positive impact on students' conceptual understanding and increases their interest in learning. A study in the United States involving physics teachers found that after participating in a professional development programme that combined the conceptual history of physics with teaching materials, all teachers in the study began to incorporate the history of science into their teaching. The teachers reported that the use of science history helped them understand the

learning process of students more deeply, while also making it easier for them to relate the development of physics theory to the material being taught.

CONCLUSION AND SUGGESTION

Based on the results of the study, it can be concluded that the learning media in the form of history-based animated videos on Archimedes' Law that have been developed meet the eligibility standards for use in the learning process. This eligibility was obtained through validation by experts, including media experts, subject matter experts, and practitioners, with an average rating in the Very Good category. In addition, the results of trials with students, both in limited trials and large group trials, showed positive responses in the Good category. Thus, the historical animated video media on Archimedes' Law material is declared feasible so that it can be used as a supporting tool in physics learning activities.

The development of historical animated video learning media can be carried out on various other physics materials. In addition, during the development process, it is hoped that the impact of media use on student learning outcomes will be measured quantitatively, so that the influence of the media on improving conceptual understanding can be proven empirically.

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