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ORIGINAL RESEARCH

Development of a digital learning module on Archimedes' law for junior high school students

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ABSTRACT

This research aims to develop a digital learning module on Archimedes law material that is suitable for use by junior high school students. The research method used is a RnD with the ADDIE model. Validation was carried out by media experts and material experts and feasibility tests by 30 students. The results of the study were obtained that the validation of the material experts on the developed modules obtained a score of 85 with a good category. Media experts gave a score of 89.4 in the good category. The results of the feasibility test of students obtained a score of 84.7 with a good category. It can be concluded that the digital learning module based inquiry on Archimedes' law developed is suitable for use by junior high school students.

Keywords: Archimedes law material · Digital learning module · Learning media · Science larning

INTRODUCTION

Science subjects at the junior high school level consist of three branches: Physics, Chemistry, and Biology. Based on interviews with students, Physics is perceived as the most difficult branch of science. This perception is supported by learning outcome data at SMPN 4 Pakenjeng, which shows that student achievement in Physics is still low, with only 60% of students meeting the expected learning outcomes. One of the contributing factors to the low achievement in Physics is the presence of several abstract concepts. Archimedes' principle is one such abstract concept, despite its frequent occurrence in everyday life. However, a lack of deep understanding of this concept can lead to misconceptions among students (Surtiana, et al., 2021).

Archimedes' principle is often considered challenging by students due to its reliance on mathematical equations that require both conceptual understanding and analytical skills to solve. Students frequently struggle to apply the concept of Archimedes' principle when faced with calculation-based problems (Kusairi et al., 2020). Although the concept can be observed in everyday life, it remains difficult for many students as it involves abstract principles (Yuliana et al., 2021)

Education is one of the key pillars in developing high-quality human resources. In the digital era, learning is no longer confined to conventional methods but has shifted toward digitalization to meet the increasingly diverse learning needs of students. One of the essential

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components in the learning process is instructional material, which contains the concepts, skills, or competencies students are expected to master.

Currently, instructional materials particularly in junior high school physics still face various limitations. Most materials are available only in printed form, which presents several drawbacks, including a lack of interactivity, difficulty in updates, high production costs, limited accessibility, and inadequate support for diverse learning styles. Furthermore, printed materials are vulnerable to physical damage such as tearing, wear, or loss, which diminishes their long-term effectiveness.

Instructional materials serve as learning media that convey knowledge to students. Learning media are defined as tools that contain instructional information or messages used in the teaching and learning process. These media play a critical role in helping students acquire new concepts, skills, and competencies (Ediyani et al., 2020).

To address these issues, it is necessary to develop a digital learning module specifically designed for teaching Archimedes' principle at the junior high school level. Digital learning modules offer advantages in terms of flexibility, interactivity, and accessibility anytime and anywhere through digital devices. Moreover, such modules can be tailored to match students' individual learning styles, thereby enhancing the effectiveness and efficiency of the learning process.

This study aims to produce a digital learning module on Archimedes' principle that is suitable for use by junior high school students. The development of this module is expected to provide a solution to the limitations of existing printed materials, support students in understanding complex concepts, and address the educational challenges of the digital age.

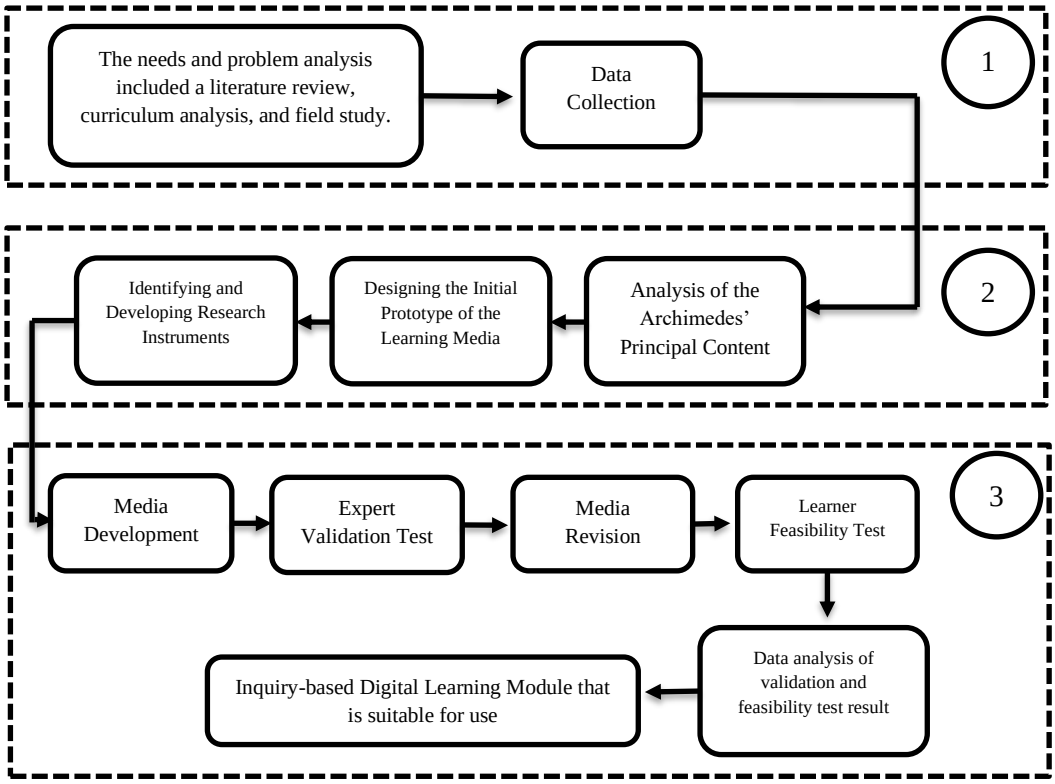

Figure 1. Media Development Flow

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METHOD

This study employed a development method aimed at producing a valid and feasible product. The model used was the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Sugiyono, 2019). However, in this study, the researcher only carried out the first three stages of the ADDIE model in accordance with the research objective, which was to develop a digital learning module that is suitable for student use. This decision was also influenced by time constraints and the need to adapt to the current learning situation and conditions. The detaile research design is provide in Figure 1.

Research Instrument

The research instruments used are media validation sheets and student response questionnaires. The media validation sheet is made in the form of a questionnaire by filling in the checklist (√) on the choices in the column provided and the comment column from the varidator. The aspects assessed in the material and media test can be seen in the Table 1 (Arshad, et al., 2022; Laksana, 2024; Perez et al., 2023)

Table 1. Aspects of Media Validation Test Assessment

Aspect Assessed	Statement
Material Aspect	Appropriateness of the material with General Instructional Objectives / Basic Competencies
	Relevance of the material in the learning module with the main subject matter
	Depth of the material according to students' abilities
	Alignment of the material with concepts listed in various physics references
	Sufficiency of examples provided according to students' learning needs
	The material in the learning module provides benefits in expanding knowledge
Linguistic Aspect	Appropriateness of image illustrations in the learning module
	Appropriateness of evaluation with the content of the learning module
	Accuracy of language use according to standard grammar (EYD)
	Use of language that avoids ambiguous meanings
	Sentence structure
	Use of communicative language
Presentation Aspect	The systematic presentation of the learning module follows the stages of learning
	The presentation of material in the module encourages students to actively think, communicate, explore, process, and conclude
	Appropriateness of the layout presented
	Buttons provided are functional
Graphic Aspect	Neatness in the writing of concepts in the learning module
	Color combinations used in the learning module
	Harmony of font types and sizes used in the learning module
	Clarity of images displayed in the learning module

The assessment indicators for each aspect use a Likert scale with the Table 2. The media validation sheet is given to media experts and material experts to review the feasibility of learning media made according to the validator's field. The material and media experts each consist of one person. The material expert is a Physics lecturer at the Garut Institute of Technology, and the media expert is a master's student in educational technology who is in his final semester.

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Tabel 2. Skala Penilaian Media yang Dikembangkan

Score	Description
1	Very Poor
2	Poot
3	Enough
4	Good
5	Very Good

The learner response questionnaire was used to determine the response of students to the digital learning module developed. The questionnaire is filled in by giving a checklist (√) on the score provided in the form of a Likert scale. Learners can provide comments / suggestions in the column provided.

Data Analysis Technique

The data obtained in the validation test in this study were each calculated using a Likert scale and categorised according to the following Table 3.

Table 3. Categories of Material and Media Experts

Skor	Kategori
91 – 100	Very Good
71 – 90	Good
51 – 70	Enough
<51	Poor

(Kemendiknas, 2010)

Students response data was processed and analysed using the following equation (1).

$$K = \frac{\sum n_i}{N} \times 100\% \quad (1)$$

Description

K : Percentage of the score obtained

$\sum n_i$: Total score obtained

N : Total maximum score

The results of the calculation based on the equation above are matched into the criteria as in the following Table 4.

Table 4. Learner Response Criteria

Score	Description
85 – 100	Very Good
70 – 84	Good
55 – 69	Enough
40 – 54	Poor
<53	Very Poor

(Kobesi et al., 2022)

RESULT AND DISCUSSION

The research conducted aims to produce a digital learning module that is suitable for use by junior high school students with the development steps of analysis, design, and development. The results of each stage in the development of this digital learning module are described as follows.

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Analysis Stage

The analysis stage is the first stage carried out in this research. This stage includes analysis of literature studies, curriculum analysis, and field analysis. Based on the results of the literature study analysis, it was found that one of the difficult science materials according to students is Archimedes' law material, many students experience misconceptions in the material (Sarniti & Oktavianty, 2018). Archimedes' law material is difficult material for students, it is often found that students have difficulty constructing knowledge of the basic concepts learned (Eris et al., 2024). Apart from during learning, when the teacher conducts remediation, students still have difficulty in changing their initial conception of Archimedes' law material and this is not in line with the increasing new concepts received by students (Wilasari & Budiyanto, 2021).

Curriculum analysis conducted in this study is by looking at the competencies that must be possessed by junior high school students for Archimedes' law material. It was found that the competencies that must be possessed are 1) identifying the relationship between the upward force and the weight of the liquid being moved, 2) providing examples of applications of Archimedes' law in everyday life, and 3) calculating the force acting on objects when in liquid.

The field analysis carried out is by looking at the phenomena that occur in the field, in this case the researcher finds that the students faced today are more familiar with their gadgets than with textbooks. Of course, this can be one of the factors that cause students to have difficulty understanding lessons. Almost all students already have smartphones and are adept at using them, while teaching materials or reading materials that are often used in learning are printed teaching materials that can only be used at school and are limited.

Based on the results of literature analysis, curriculum analysis, and field analysis obtained, learning media is needed that can help students understand science material, especially Archimedes' law material. By utilising technology, the media that can be developed is a digital learning module on Archimedes' law material for junior high school students. The module can be prepared according to the needs of students and can be used by students anytime and anywhere.

Design Stage

The design stage is the second stage in this research. In the design stage, the researchers analysed the material of Archimedes' law, namely analysing what material will be presented in the digital module. Obtained material to be presented includes 1) the concept of density, 2) Archimedes' law, and 3) application of Archimedes' law in everyday life. Furthermore, researchers determined the systematics of the digital module developed and it was decided that the systematics included 1) cover, 2) preface, 3) Table of contents, 4) introduction (consisting of a brief description, competency map and learning instructions), 5) learning activities (consisting of competency achievement indicators, learning objectives, material descriptions, exercises, summaries, formative tests, and answer keys), and 6) bibliography. The flowchart made for the developed media can be seen in the Figure 2.

After the material and systematics are determined, the next step in this stage is to compile an instrument for the feasibility test of the developed digital module. The instruments compiled

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include material expert and media expert validation instruments and student feasibility test instruments. Each instrument is made on a Likert scale (Jebb et al., 2021).

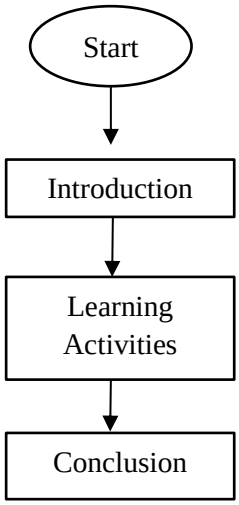

Figure 2. Flowchart of the Developed Media

For the material expert validation instrument, the aspects to be assessed are material and language. While the media expert validation instrument aspects of the assessment are presentation, language and graphics. The learner feasibility test instrument includes aspects of interest assessment, material readability, and language.

Development Stage

The development stage is the final phase carried out in the research. In this stage, the researcher creates the digital learning module on Archimedes' principle in accordance with the design phase. The researcher used Microsoft Word to prepare the learning module. Once completed, the next step was to input the module into the Flip HTML5 application, and then the link to the Flip HTML5 module was shared with the students (Unes, et al., 2024). The appearance of the completed learning module can be seen in Figure 3.

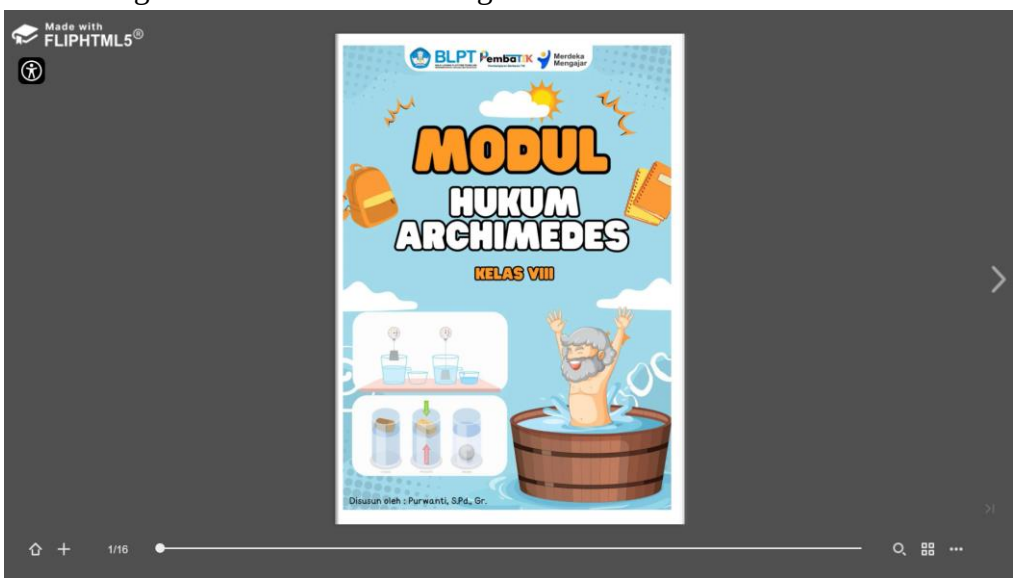

Figure 3. Cover View of Digital Learning Module on Archimedes' Law

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The initial display or cover includes the title of the developed learning module, which is Archimedes' principle, the target users of the module, which is eighth-grade students, and is complemented by images related to Archimedes' principle. The cover of the learning module should be designed as attractively as possible to encourage students to read and study the material within the module (Setiawan et al., 2022).

The next page includes the preface and Table of contents. Before presenting the material, the researcher provides an introduction in the module. The appearance of the introduction can be seen in Figure 4.

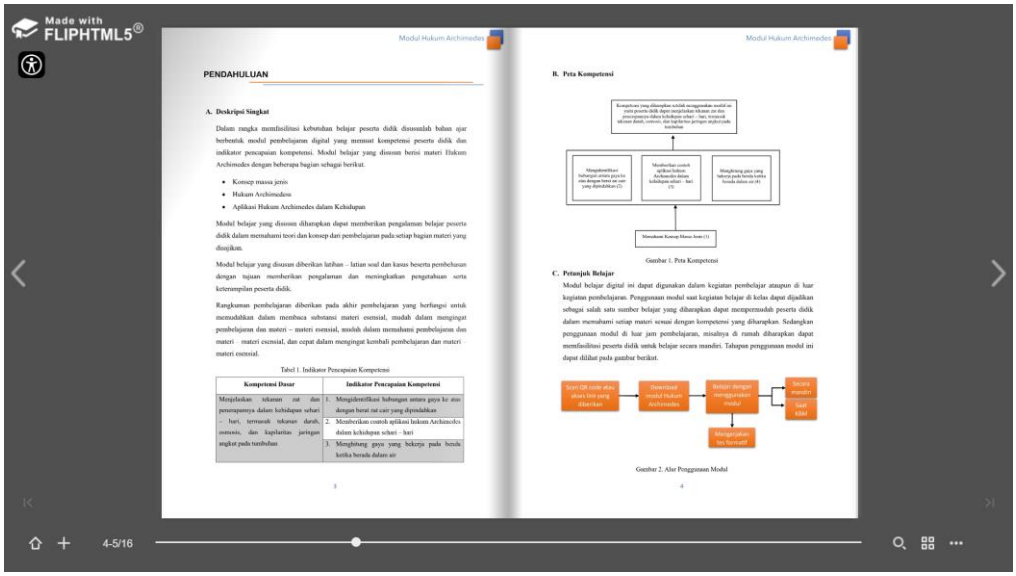

Figure 4. Introduction to the Digital Learning Module on Archimedes' Law

The introduction contains a brief description of the material contained in the learning module as well as the basic competencies and competency indicators that must be achieved by students. In this section, instructions for using the module are also given. As for the display of learning activities can be seen in the following Figure 5.

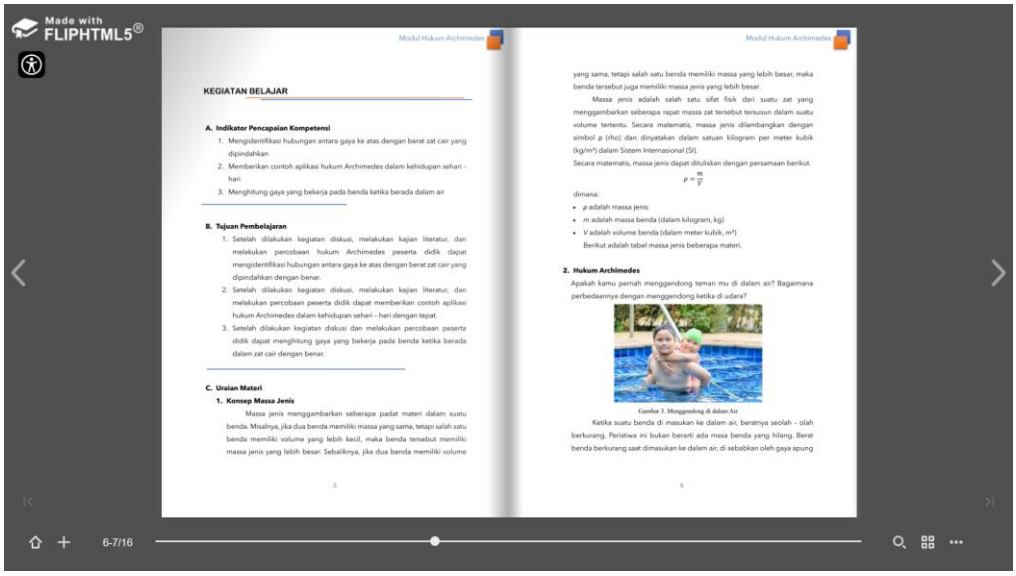

Figure 5. Learning Activity Display of Archimedes' Law Digital Learning Module

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The display of learning activities is the content of the developed module. In this section contains learning indicators, learning objectives, material descriptions, sample questions, summaries, practice questions, formative tests, and a list of references from the module. One part of the material display of the developed module can be seen in Figure 6.

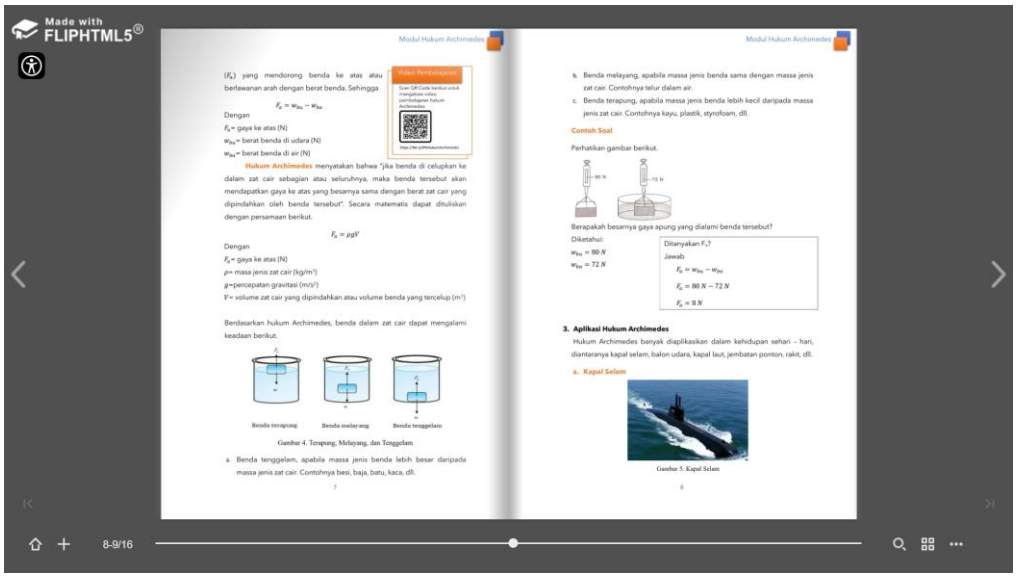

Figure 6. Digital Learning Module Material Display of Archimedes' Law

The material presented is equipped with image illustrations and a QR Code that can be used by students to access the learning video of Archimedes' law material so that it is expected to fulfil the diverse learning styles of students. Two learning media that have the potential to accommodate individual learning styles are learning videos and animations (Kurniawan, 2017; Damayanti, 2020). The next step after making the digital learning module of Archimedes' law is to conduct validation tests to material experts and media experts. The results of material expert validation can be seen in Table 5.

Table 5. Hasil Validasi Ahli Materi

No.	Assessed Aspects	Score	Interpretation
1.	Content	90	Good
2.	Linguistic Aspect	80	Good
Average		85	Good

Material expert validation for the material aspect received a score of 90 with a good category, while for the linguistic aspect received a score of 80 with a good category. So that the average material expert validation results obtained a score of 85 with a good category. The results of media expert validation can be seen in Table 6.

Table 6. Media Expert Validation Results

No.	Assessed Aspect	Score	Interpretation
1.	Presentation	93,3	Very Good
2.	Linguistic	85	Good
3.	Graphical	90	Good
Average		89,4	Good

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The expert validation of the media was conducted on three aspects: presentation, language use, and graphical aspects. The presentation aspect received a score of 93.3, categorized as excellent. The language use aspect received a score of 85, categorized as good, and the graphical aspect received a score of 90, categorized as good. Therefore, the average score of the expert media validation was 89.4, categorized as excellent. The qualitative data obtained from the content experts and media experts consisted of suggestions, which can be seen in Table 7.

Table 7. Validator's Suggestions

Physics Experts	Learning Media Experts
Overall, the module is well-developed; however, there are a few areas that could be improved, such as: 1) The text alignment (left-right) is not uniform. 2) The evaluation questions are still limited. 3) The material could be written in a more communicative and engaging manner.	The visualizations should be added further

After receiving suggestions from the content and media experts, the researcher made revisions according to the provided guidance. The researcher improved the formatting of the text to align with both left and right margins. Additionally, the researcher added evaluation questions to the developed module. Test sheets or evaluation sections are the final components in a learning module that contain assessment questions aimed at measuring students' understanding of the material being studied (Liliawati et al et al., 2024). Furthermore, the researcher modified certain language styles to make them more communicative. The researcher also incorporated visualizations based on the media experts' suggestions, focusing on the application of Archimedes' principle in daily life (Kriek & Legesse, 2023).

The next stage, after validation and revision, involved conducting a feasibility test of the developed media with 30 junior high school students, and the data obtained is presented in Table 8

Table 8. Results of Media Feasibility Test by Students

No.	Assessed Aspect	Score	Interpretation
1.	Interest	83,8	Good
2.	Content Readability	86,7	Good
3.	Language	83,6	Good
Average		84,7	Good

Based on Table 4, the interest score was 83.3, categorized as good; the material score was 86.7, categorized as good; and the language score was 83.6, categorized as good. Therefore, the average score from the student feasibility test was 84.7, categorized as good. Based on Tables 5, 6, and 8, the average scores from the expert validation (content and media experts) and the student feasibility test are presented in a bar chart in Figure 7.

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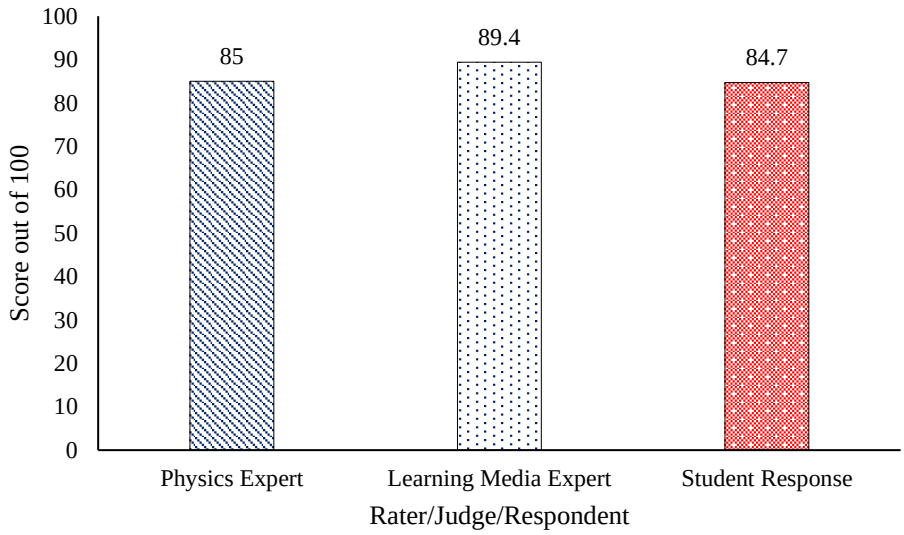

Figure 7. Feasibility Test Results

Based on Figure 7, it can be concluded that the results of the feasibility test, whether from the content experts, media experts, or students, all fall within the "good" category. This indicates that the developed digital learning module on Archimedes' principle is suitable for use by junior high school students.

The digital module using Flipbook HTML 5 is deemed appropriate for learning, as evidenced by the research of ,Abdi et al. (2023), which showed that digital Flipbook modules are suitable for teaching science to improve students' science literacy on the topic of the human digestive system. The study by Rizki et al., (2022) found that the development of digital science modules can be used in teaching the energy sources topic through a contextual teaching approach. According to Hadiyanti (2021) and Anggraini et al (2023), the Flipbook-based digital science learning modules are suitable for use in learning. Furthermore, Riyanti and Lubis (2024) stated that the development of Flipbook-based digital modules is practical for science education.

CONCLUSION

Based on the results of the content expert validation, media expert validation, and the student feasibility test, it was found that the content expert gave a score of 85, categorized as good, the media expert gave a score of 89.4, categorized as good, and the students gave a score of 84.7, categorized as good. Therefore, it can be concluded that the developed digital learning module on Archimedes' principle is suitable for use by junior high school students.

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