Teaching Module with Project-Based Learning Model to Train Students' Problem-Solving Skills on Archimedes' Law: Validity Review

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Abstract. Problem-solving skills of grade XI students in one of the Senior High Schools in Barito Kuala Regency are important to train. There is also no teaching module that can train problem-solving skills. To overcome this problem, a study was conducted that aims to produce a teaching module based on a project-based learning model to train students' problem-solving skills on the material of Archimedes' law. This article will explain the feasibility of the teaching module based on its validity. This research method is research and development that focuses on testing the validity of the teaching module. The research instrument used is a validation sheet to measure validity using a Likert scale. The results of the study showed that the validity of the teaching module was categorized as valid. Based on these findings, it can be concluded that the developed teaching module is feasible to be used in the next feasibility test to determine its effectiveness in training students' problem-solving skills.

Keywords: problem solving skills, project-based learning, teaching module

1 Introduction

The PjBL model requires students to be able to understand the problems they are facing and try to solve these problems with products made either independently or in groups with the aim of making students more active in the learning process, providing readiness for students to be able to face problems in real life, so that it will focus students to be interactive during the learning process and encourage students to be more creative individually with their surrounding environment [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15]. This model can train problem-solving skills that allow students to train 21st-century skills such as creativity, collaboration, communication, and technological skills that can be used to solve problems in real life [1], [16], [17], [18], [19].

Problem-solving skills are essential because they help us face challenges and find effective solutions in complex situations. In addition, these abilities facilitate better and more effective decision-making in various aspects of life, both personal and professional [20]. The problem-solving skills of students trained are based on The Osborn Parnes theory which focuses on

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creative problem solving, which consists of several main stages, namely objective finding, fact finding, problem finding, idea finding, solution finding and acceptance finding [21]. To train these skills to students, of course, it must be adjusted to the material that will be studied at school. There are many physics materials that can train students' problem-solving skills, one of which is static fluid material related to Archimedes' law [22], [23]. This material is suitable for use because it is basic material that is closely related to everyday life, especially the material on Archimedes' law, so that it will make students think more and be able to find problems and be able to solve them with the concepts and theories that will be studied [24], [25], [26].

To be able to train students' problem-solving skills on Archimedes' law material well, of course a good design of each activity or learning strategy is needed to provide treatment to students in the learning process, in which case a teaching module that is of course very necessary is needed. will provide an overview of how the semester activities should run [25], [27], [28].

Based on the existing background, it is necessary to conduct research and development of teaching modules related to Archimedes' law material based on Project-Based Learning (PjBL) in order to improve students' problem-solving skills. The feasibility of the teaching module is seen from the validity test of the module [4], [29], [30], [31]. The validity of a teaching module is the level of conformity between the developed teaching module and the objectives of the compilation and curriculum, based on assessments by practitioners and academics. This article aims to describe the results of the validity test of the teaching module related to the material of Archimedes' law based on Project-Based Learning (PjBL) in order to improve students' problem-solving skills.

2 Method

Data collection was carried out in July 2024 and implemented at SMA Negeri 1 Mandastana. The validity of the developed teaching module consists of the contents of the teaching module, worksheets and Learning Outcome Tests. Validity is carried out to see whether the developed teaching module is able to reveal data from the variables being studied. The validity data of the teaching module is obtained from the results of the assessment by expert validators and practitioner validators. The results of the validity are then tested for reliability.

The teaching module validity instrument is a validation sheet used to provide validation of the research product by a validator. The sheet is used to measure the level of accuracy of the developed module. The teaching module validation instrument consists of a teaching module content validation instrument, a worksheet validation instrument and a learning outcome test validation instrument. Validation is carried out by 3 validators, namely experts consisting of two academic validators and one practitioner validator.

The validity of the teaching module is assessed based on the average score of the validator's assessment obtained from the teaching module assessment instrument, then categorized based on the following guidelines [32].

$$\text{Score of Validation} = \frac{Total\ score\ of\ validators}{Number\ of\ validators} \quad (1)$$

Table 1. Teaching Module Validation Score Categories

Average ($\underline{x}$)	Category
$3{,}2 < \underline{x} \leq 4{,}0$	Very good
$2{,}4 < \underline{x} \leq 3{,}2$	Good
$1{,}6 < \underline{x} \leq 2{,}4$	Poor

$0{,}8 < \underline{x} \leq 1{,}6$	Not good
$0{,}0 < \underline{x} \leq 0{,}8$	Very bad

In addition, the learning module is also tested for reliability to determine its level of consistency. The reliability of the learning module is calculated using the percentage agreement between the three validators. To determine the percentage agreement, the following equation is used:

$$\text{Percentage of agreement} = \left(1 - \frac{A-B}{A+B}\right) \text{ x } 100\% \quad (2)$$

Description:
A = Highest frequency
B = Lowest frequency
The learning device assessment instrument will be reliable if the percentage agreement value $\geq$ 75%.

3 Results and Discussion

Learning devices are a very important component in the learning process, if the devices used have problems, of course this will have an impact on the implementation process that will be carried out to students in class. Thus, it is very important to know the feasibility of the devices that have been developed before being applied to students. The teaching module as part of the learning device that has been developed for this study, was tested for its feasibility to determine the level of feasibility of the module that has been developed. Validated by two lecturers from the Physics Education study program at Lambung Mangkurat University and one physics educator from SMA Negeri 1 Mandastana. By using a validation instrument sheet consisting of several criteria including the contents of the teaching module, student worksheets and learning outcome tests. The following are the results of the validation of the devices that have been developed as follows.

3.1 Content of the Teaching Module

The teaching module is a learning device designed to map learning activities systematically and structured, so that with the teaching module the learning target can be described well and quite clearly. The creation of teaching modules must of course be adjusted to the development of students and consider the learning objectives to be achieved, so that this will make it easier to describe the achievements that will be obtained by students. In this study, the teaching module developed is adjusted to the demands of the independent curriculum with a project-based learning model to train problem-solving skills for class XI students at SMA Negeri 1 Mandastana. The contents of the teaching module developed consist of three component parts, namely general information, core components and attachments. The general information section consists of identity, initial competencies, Pancasila learning profiles, facilities and infrastructure, student targets, number of students, learning methods/models. The core component section consists of the flow of learning objectives, meaningful understanding, trigger

questions, learning activities, student reflections. The attachment section consists of student worksheets, reading materials, glossaries and bibliographies. A good teaching module includes parts of these components with good development, so that the results of the products that have been developed are as results that are worthy of use. The following are the results of the analysis of the validity data of the teaching module content presented in table 2.

TABLE 2 Results of the Validity of the Teaching Module Content

Aspect	Average of Validity		Reliability	
	Score	**Categoriy**	**PA**	**Categoriy**
Module Format;	3.5	Very Good		
Language;	3.5	Very Good		
Module Contents;	3.6	Very Good	96.64%	**Reliable**
Suitability of Presentation;	3.5	Very Good		
Benefits of Teaching Modules	3.6	Very Good		

The table above shows the average results of the values obtained for the contents of the teaching module that has been developed from the three validators categorized as very good. Although this is inseparable from suggestions and criticisms to be able to reconsider the learning objectives that have been set and errors in writing. Apart from that, the data obtained above shows that the teaching module with a project-based learning model to train problem-solving skills that has been developed is a valid module with a reliability value obtained based on the percentage agreement assessment obtaining a value above 75% with a reliable category, and can be used for research in schools with students. In terms of the validity of the contents of the teaching module, there are several criteria that must be met to obtain a good assessment for the suitability of the contents of the teaching module to be used, including the format of the teaching module, language, contents of the teaching module, suitability of presentation and benefits of the use of the teaching module. In this aspect, the assessment of the three validators is certainly different. To sum up the results of the assessments given by the validators, it is necessary to sum up all the scores obtained in each aspect, then the results will be divided by the number of criteria from the aspect, so that the average value of each aspect will be obtained as shown in Table 2.

In terms of the format, the teaching module gets results with a very good category. The format of the teaching module has been prepared in accordance with the Independent Curriculum, with a structured numbering system, the right type and size of font, and a balance between text and image illustrations, between components and sub-components are also arranged regularly. The language aspect of the module also gets a very good rating, indicating that the language used is in accordance with Indonesian language rules, consistent in the use of symbols and symbols, illustrations are in accordance with the substance of the message to be conveyed in the material, and there is no double meaning. The content aspect of the teaching module gets a very good rating, indicating that the contents of the module have been prepared in accordance with the Independent Curriculum. In this curriculum, there is a change in the terminology in the core competency section in the learning objective achievement indicator replaced by learning objectives, which combine knowledge and skills as a process to develop student competencies. The results of the module content assessment show that the accuracy of the concepts in the material is appropriate, the use of scientific nomenclature, terms, and unit

symbols is correct, and the module content is closely related to the development of problem-solving skills in everyday life.

In terms of the suitability of the presentation of the teaching module, a very good category was obtained, indicating that the preparation of the module has met the necessary important components. This component includes general information, Core Components, and Attachments. General Information consists of identity, initial competencies, Pancasila learning profiles, facilities and infrastructure, student targets, and learning methods/models. The Core Components include learning objectives, trigger questions, learning activities and student reflections. Attachments include various documents such as Student Worksheets, attitude assessments, formative assessments, summative assessments, assessment rubrics, reading materials, glossaries, and bibliographies. Overall, this teaching module is considered to have been well prepared in accordance with the principles of the independent curriculum. In terms of the benefits of the teaching module, it received validity with a very good category, this indicates that the teaching module can be used as a guideline by educators in the learning process. Educators agree that the criteria for teaching modules must be made in an interesting, challenging, and meaningful way, with the hope of increasing students' interest in learning and involving students actively during the learning process.

Overall, the results of the validity of the content of the teaching module achieved an assessment with a very good category and have met the standards of the components of the content of the teaching module that are suitable for use in learning activities. The validation that has been carried out is certainly inseparable from suggestions and criticisms from several validators, in this aspect there are several suggestions for improvement to the researcher including considering the scope of learning objectives, especially since you have mentioned that your material description starts from "hydrostatic pressure, Pascal's Law and Archimede's law!". Suggestions for improvement are very much needed by the author to be able to develop learning products that are more effective and useful when applied in schools. Based on the suggestions for improvement that have been given, the researcher made improvements by re-discussing the developed device with the supervisor regarding this matter, and there were several errors that the researcher wrote in the developed module according to the criticism that had been given. Related to the discussion of material that does not represent the overall discussion, improvements were also made by adding a discussion of static fluid material to the teaching materials/reading materials made for students and improvements to the writing of learning objective indicators that were not appropriate based on suggestions and improvements from the validator to improve the quality of the teaching module product that will be developed in order to maximize the use of the teaching module developed in the implementation of research in learning in schools to train students' problem-solving skills using the project-based learning model.

Fig. 1. Title Cover After Repair; and Static Fluid Teaching Material

The suitability of the contents of the teaching module is very important because it concerns the contents of the material that will be taught in the textbook and is a standard that must be met in the textbook, therefore the assessment of the suitability of the contents of the module is very important [33], [34], [35], [36]. The validation assessment on the content aspect of the teaching module obtained a good value with an average result as in the table with an average category of very good and the acquisition of reliability values based on the percentage agreement value obtained a value above 75% which indicates that the teaching module is categorized as reliable. With this, the contents of the developed module are declared feasible to be applied in schools during the research.

3.2 Student worksheets

Student worksheets are developed by adjusting from the developed teaching module. The Student Worksheets in this module are made in two parts, namely the first part to provide a general understanding of the material, understand the problems given, create a project design that will be made according to the material discussed. The second part is the project worksheet which contains an analysis of the previously made design and then the product design that will be made by adjusting to the results of the analysis that has been done previously. The Student Worksheet is certainly made to adjust to the indicators of problem-solving skills to be trained on students and to adjust to the situation of the project-based learning model. The following are the results of the data analysis on the validity of the Student Worksheet presented in Table 3.

Table 3. Results of Validity of Student Worksheets

Aspect	Average of Validity		Reliability	
	Score	Category	PA	Category
Format	3.6	Very Good		
Language	3.4	Very Good	99.14%	Reliable
Content	3.6	Very Good		

From table 3 it is explained that the validity value of the Student Worksheet that has been developed is included in the very good category. However, it does not rule out the possibility of deficiencies in the Student Worksheet that has been made. There are several suggestions given

by the validator regarding the material discussed in the Student Worksheet that has been developed, such as suggestions given to researchers to reconsider the material to be discussed in the Student Worksheet, and need to be discussed again with the supervisor. With the suggestions given, of course, there will be improvements for the perfection of the Student Worksheet that will be developed. Therefore, based on the results obtained, the Student Worksheet based on the project-based learning model to train students' problem-solving skills that have been made is said to be valid with the acquisition of a reliability value based on the percentage agreement assessment obtaining a value above 75% with a reliable category and can be used to be applied to research in schools.

Student worksheets or commonly abbreviated as Student Worksheets are part of the teaching materials, namely printed teaching materials compiled by educators which are useful for the learning process that will be given to students which must be implemented [37], [38]. In the aspect of the student worksheet, there are several criteria that must be met to obtain a good assessment, these criteria consist of the format of the Student Worksheet, the language and content of the Student Worksheet. From the validator there are suggestions for improvement that must be reconsidered by the researcher, because based on the design of the Student Worksheet that has been made, it only trains learning activities that focus on the material of Archimedes' Law, while the module developed refers to the discussion of Static Fluids.

The results of the validity include several criteria in the assessment including the format of the Student Worksheet, language and content of the Student Worksheet. In the Student Worksheet format criteria, it was found that the format of the Student Worksheet objectives was clear with the size and type of font that was in accordance with the layout and the Student Worksheet was accompanied by a good work procedure and the answer space on the Student Worksheet that was made was in accordance with the answer key. In the language criteria, the assessment results showed that the language on the Student Worksheet that was made used language that was in accordance with the correct Indonesian language rules, and the language used was simple so that it was easy to understand and sentences did not cause double meanings. The structure of a good Student Worksheet is a Student Worksheet that includes linguistic components such as the suitability of linguistic rules that are in accordance with Indonesian and in accordance with the level of students/simple and easy to understand language. Meanwhile, in the content criteria of the Student Worksheet, the assessment results show that the Student Worksheet already contains problem-solving skills, is relevant to the project-based learning model phase in the Student Worksheet that was developed, and the suitability of the concept and material of static fluids in everyday life, and can encourage students to be able to learn independently.

Based on the suggestions given, the researcher made improvements again, by considering changing the title of the teaching material or keeping the same title with slight modifications. By considering these two things, the researcher decided to change the title of the teaching material, and provide modifications to the teaching material that had been created with the assumption that the teaching material developed already covered all the material from static fluids and could be used by students as independent learning materials.

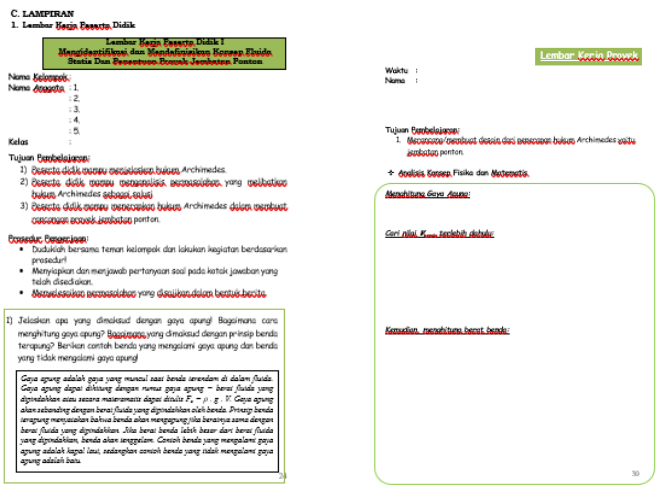


Fig. 2. Student Worksheet

The assessment results from the validation of the Student Worksheet aspect obtained a good value with a very good category with the acquisition of a reliability value based on the percentage agreement value obtaining results above 75% with a reliable category. Based on the research [39], [40], [41] with the results of the validation of the Student Worksheet with a good category, it can be concluded that the Student Worksheet developed is worthy to be given to students to be able to practice problem-solving skills.

3.3 Learning Outcome Test

The learning outcome test is made to determine the extent of the effectiveness of the learning activities that will be applied to students, by comparing the pretest and posttest values, it will be able to provide an overview of the results of the effectiveness or ineffectiveness of a learning activity in achieving its goals. This test is carried out by providing test questions at the beginning before the learning activity begins as a pretest, and after that it will be followed by providing test questions in the final session after students are given treatment. In making a learning outcome test, there is not much difference between the questions that will be given before and the questions given after the treatment. These questions must have the same quality, the same level as before, but they must not be the same as a whole, because if the questions are made the same as a whole, it will certainly reduce the quality of the character of the questions and will not achieve the actual target. The learning outcome test is developed in accordance with the learning objectives with the subject matter of Archimedes' law in particular. This question was created by adjusting the indicators of the achievement of the objectives of this research, namely to train students' problem-solving skills, namely focusing on problems, describing problems, planning solutions, implementing solutions, checking and evaluating.

The learning outcome test before being given as a final test for students is given first when the learning process is ongoing, so that students will receive treatment that is in accordance with what will be tested on students. With this, students will generally be able to provide good

problem solving because they have been trained. The following are the validation results of the learning outcome test that has been developed presented in Table 4.

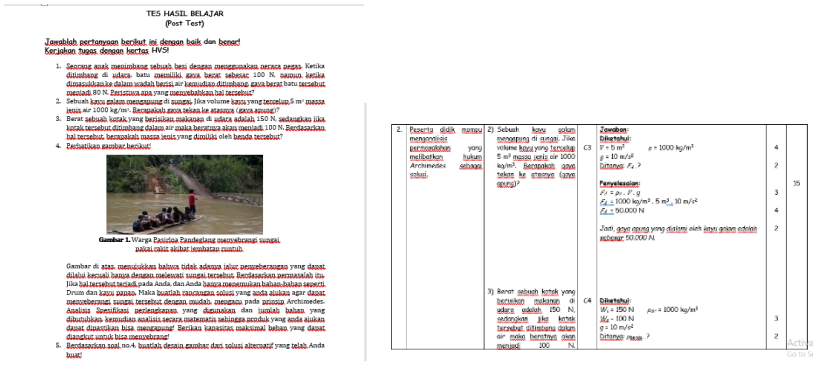
Table 4. Learning Outcome Test Validation Results

Aspect	Question					Reliability	
	1	2	3	4	5	PA	Category
Topic	3.58	3.66	3.66	3.58	3.50		
Construction	3.60	3.53	3.66	3.66	3.53		
Language	3.53	3.66	3.53	3.66	3.60		
Problem Solving Skills	3.53	3.53	3.53	3.66	3.66	98.97%	Reliable
Average	3.56	3.59	3.59	3.64	3.57		
Validity Category	Very Good	Very Good	Very Good	Very Good	Very Good		

Based on Table 4 shows the results of each aspect of the assessment of topics, construction, language, and problem-solving skills that all aspects of the assessment get a very good category. This means that the questions that will be used as student learning outcome tests are worthy of being used as a measuring tool to determine the development of student problem-solving skills. However, there are several suggestions for improvement to further maximize the instrument, such as making clearer assessments on certain questions and making slight changes to the questions because they seem too similar so that they will reduce the quality of the questions that have been made. It was concluded that the learning outcome test based on the project-based learning model to train students' problem-solving skills that was developed can be said to be valid with the acquisition of reliability values based on the percentage agreement assessment obtaining a value above 75% with a reliable category for and can measure students' problem-solving skills. The learning outcome test questionnaire aspect also has several criteria that must be met properly for the learning outcome test questionnaire to be used properly and worthy of measuring students' problem-solving skills. The learning outcome test is measured based on several aspects, namely topics, construction, language and in accordance with problem-solving skills. In terms of the topic of the questions created, the results obtained state that the questions that have been created are in accordance with the learning objectives, the truth of the physics concept with the question items is also the same, the suitability of the questions with the level of education is also the same and the answer key that has been created is also in accordance with the actual concept. The question criteria will be very valid if each question item on the test instrument is adjusted to the learning achievement [42].

In the construction aspect, it was assessed that the results of the questions that had been made did not contain double meanings, clear images, there were instructions for working on the questions, guidelines for using the test were conveyed clearly and the presentation of the reading text in the instrument was arranged systematically. Then in the language aspect, the assessment results were obtained that the language used was communicative, did not use the local language, the sentences used were effective and in accordance with the general guidelines for Indonesian spelling and one sentence. As for the problem-solving skills aspect, it was assessed that the questions that had been made were in accordance with the content and context aspects and in accordance with the aspects of the problem-solving skills indicators of students. There were

suggestions for improvements to the learning outcome test used, namely that the questions to measure the learning outcome test of students should not be the same between the questions given before learning and after learning was implemented, with the consideration that it would be able to reduce the level of question characteristics. The other is related to the assessment method which is less specific in each aspect of the question item, to facilitate students' assessment of the answers given. Based on the suggestions for improvement that have been given, the researcher again improved the questions that will be used to assess the extent of students' problem-solving skills, by creating similar questions and at the same level with slightly different instructions from the previous ones and improving the method of giving points to students' answers for each question item created.



TES HASIL BELAJAR
(Post Test)

Jawablah pertanyaan berikut ini dengan baik dan benar!
Kerjakan tugas dengan kertas HVS!

1. Seorang anak menimbang sebuah besi dengan menggunakan neraca pegas. Ketika ditimbang di udara, batu memiliki gaya berat sebesar 100 N, namun ketika dimasukkan ke dalam wadah berisi air kemudian ditimbang gaya berat batu tersebut menjadi 80 N. Peristiwa apa yang menyebabkan hal tersebut?
2. Sebuah kayu dalam mengapung di sungai. Jika volume kayu yang tercelup 5 m^3 massa jenis air 1000 kg/m^3. Berapakah gaya tekan ke atasnya (gaya apung)?
3. Berat sebuah kotak yang berisikan makanan di udara adalah 150 N, sedangkan jika kotak tersebut ditimbang dalam air maka beratnya akan menjadi 100 N. Berdasarkan hal tersebut, berapakah massa jenis yang dimiliki oleh benda tersebut?
4. Perhatikan gambar berikut!

Gambar 1. Warga Pasirjoa Pandeglang menyeberangi sungai, paksi relic akibat lembaran rumah.

Gambar di atas, menunjukkan bahwa tidak adanya jalur penyeberangan yang dapat dilalui kecuali harus dengan melewati sungai tersebut. Berdasarkan permasalah ini, jika hal tersebut terjadi pada Anda dan Anda hanya menemukan bahan-bahan seperti Drum dan kayu papan. Maka buatlah rancangan solusi yang anda alukan agar dapat menyeberangi sungai tersebut dengan mudah, mengacu pada prinsip Archimedes. Analisis Spesifikasi, perlengkapan yang dibutuhkan dan jumlah bahan yang dibutuhkan kemudian analisis secara matematis sehingga sesuai yang anda alukan dapat dipastikan bisa menggunung! Berikan kapasitas maksimal beban yang dapat ditopang untuk bisa menyeberang!
5. Berdasarkan soal no.4, buatlah desain gambar dari solusi alternatif yang telah Anda buat!

2.	Peserta didik mampu menyimpulkan permasalahan yang melibatkan hukum Archimedes sehingga solusi.	2) Sebuah kayu dalam mengapung di sungai. Jika volume kayu yang tercelup 5 m^3 massa jenis air 1000 kg/m^3. Berapakah gaya tekan ke atasnya (gaya apung)?	C3	**Jawaban:** **Diketahui:** $V = 5\ m^3$ $\rho = 1000\ kg/m^3$ $g = 10\ m/s^2$ Ditanya: F_a ? **Penyelesaian:** $F_f = \rho_f \cdot V \cdot g$ $F_a = 1000\ kg/m^3 \cdot 5\ m^3 \cdot 10\ m/s^2$ $F_a = 50.000\ N$ Jadi, gaya apung yang dialami oleh kayu dalam adalah sebesar 50.000 N.	4 2 3 4 2	15
		3) Berat sebuah kotak yang berisikan makanan di udara adalah 150 N, sedangkan jika kotak tersebut ditimbang dalam air maka beratnya akan menjadi 100 N.	C4	**Diketahui:** $W_u = 150\ N$ $\rho_{air} = 1000\ kg/m^3$ $W_a = 100\ N$ $g = 10\ m/s^2$ Ditanya: ρ_{benda} ?	3 2	

Fig. 3. THB Questions For Posttest After Improvement; TBH Score After Improvement

Learning outcome tests are one way that can be used to measure students' abilities after being given treatment in the learning process. [25], [43], [44], [45], [46], [47]. The assessment results of the three validators on the learning outcome test that has been made are obtained with good values as in Table 4 with a very good category with the acquisition of reliability values based on the percentage agreement assessment obtaining a value above 75% with a reliable category. This shows that the learning outcome test that has been made is suitable for use in research to determine students' problem-solving skills.

4 Conclusion

Based on these findings, it can be concluded that the developed teaching module is feasible to be used in the next feasibility test to determine its effectiveness in training students' problem-solving skills.

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