



# Development of Problem-Based Independent Curriculum Physics Teaching Module to Improve Students' Critical Thinking Skills

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**Abstract:** This research aims to: design a problem-based independent curriculum physics teaching module to improve students' critical thinking skills that meet valid criteria; design a problem-based independent curriculum physics teaching module to improve students' effective critical thinking skills based on teacher practitioner assessments; design a problem-based independent curriculum physics teaching module to improve students' critical thinking skills effective based on the assessment of student practitioners; analyzing the effectiveness of the use of the problem-based independent curriculum physics teaching module to improve the critical thinking skills of students of SMA Negeri 3 Makassar City that has been developed. The method used to achieve this goal is R&D using the development of 4D models. The sample of this study is 38 00 students and 10 physics teachers in Makassar city. The instruments used in this study were module validation sheets, practitioner assessment questionnaires, and students' critical thinking ability test instruments. Based on the results of the analysis, it was obtained that: the independent problem-based curriculum physics teaching module developed based on expert assessments was declared valid and suitable for use with a slight revision; the physics teaching module of the independent problem-based curriculum reviewed from the teacher's response for all aspects obtained an average score percentage of 85% at the very good criterion; the problem-based independent curriculum physics teaching module reviewed from the students' responses for all aspects obtained an average score percentage of 86% on the very good criteria; The effectiveness of the use of problem-based physics teaching modules was obtained from the results of the students' critical thinking ability test that was effectively used with an N-gain score of  $0.84 \geq 0.70$ , with a high category. From the results of the analysis, it can be concluded that the problem-based physics teaching module developed is valid, practical, and effective to improve students' critical thinking skills in physics learning.

**Keywords:** Critical thinking; Problem-based; Teaching modules

## Introduction

The Ministry of Education and Culture formulates a 21<sup>st</sup> century learning paradigm. The paradigm emphasizes the ability of students to search burn from various sources, formulate problems, think analytically, and work together and collaborate in solving problems. This emphasis is then explained in Framework in previous 21<sup>st</sup> century learning (Kemendikbud, 2021).

According to BSNP in Amiruddin et al. (2021) Framework 21<sup>st</sup> century learning includes: for Critical thinking and solving Problem (critical thinking and problem solving skills); ability to communicate and cooperate (Communication and collaboration skills); the ability to create and renew (creativity and innovation skills); Information and Communication Technology Literacy (Information and Communication Technology Literacy); contextual learning skills (Contextual

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Learning Skills); and information and media literacy skills. Sixth Framework Help students to not only have a good understanding, but they can also improve skills and character that are acceptable in the community.

Even more complex are the skills needed to face the 21<sup>st</sup> century as stated by US-based Apollo Education Group, which identifies ten skills needed in the 21<sup>st</sup> century, namely critical thinking, communication, leadership, collaboration, adaptability, productivity and accountability, innovation, global citizenship, ability and soul Entrepreneurship, as well as the ability to access, analyze, and synthesize information (Kaya et al., 2025). From this explanation, it can be seen that the 21<sup>st</sup> century learning paradigm also affects the content of the teaching materials used by teachers, especially in physics learning.

The teaching module of the independent curriculum is a document that contains the objectives, steps, and learning media, as well as the assessment needed on one unit/topic of the learning objective flow. Teachers can create their own teaching modules, choose, and change them according to the context, characteristics, and needs of the students. Meanwhile, in the 2013 curriculum, the teaching tool only explains the learning procedures and structures used to achieve basic competencies which are determined based on content standards explained through the educational syllabus and consist of several components, namely subject identity, basic competencies, competency standards, learning objectives, indicators of competency achievement, time allocation, and learning resources (Anggraena et al., 2022).

To obtain concrete data on the physics teaching module and the physics learning situation in schools, the researcher conducted observations and interviews related to the teaching module as well as an analysis of the characteristics and competencies of class X students at SMA Negeri 3 Makassar. The initial observation was carried out to 4 physics teachers on Monday, October 16, 2023. Based on the results of interviews with physics teachers at SMA Negeri 3 Makassar, information was obtained that the teaching modules used by teachers still use teaching modules downloaded directly from the Independent Teaching Platform (PMM) application and cannot be used by students to study independently at home, so students' dependence on teaching modules is very high. In addition, the methods used by teachers are less interesting and monotonous so that they cannot meet the learning needs of students in the school environment, resulting in a lack of understanding and skills of students' learning processes. This is an obstacle in learning, where there is still a lack of students' ability to draw a logical conclusion to make a conjecture and hypothesis as well as the lack of students' ability to

present results by giving clear reasons. One way to overcome this is to develop physics teaching modules in accordance with the independent curriculum that applies at SMA Negeri 3 Makassar.

Furthermore, an analysis of students was carried out so that information was obtained that the number of class X in SMA Negeri 3 Makassar was 10 classes, among the 10 classes that will be the focus of this research is 1 class. Based on the results of initial observations, the researcher conducted interviews with 28 people out of 38 class X students at SMA Negeri 3 Makassar on Monday, June 12, 2023 to Wednesday, June 14, 2023, and came to several conclusions, namely, first, 23 students out of 28 people in class were not able to understand physics subject matter well due to the lack of availability of teaching modules used for independent learning so that critical thinking skills in solving physics problems/problems were not honed well and students' interest in physics lessons was reduced. Second, students in doing the practice questions given tended to work together, causing them to depend on each other. Third, the scope of material contained in the module is not associated with physical events/problems that occur in students' daily lives.

From the results of these observations, it can be seen that students need learning that is closer to daily life so that students get meaningful learning and can improve critical thinking skills in solving problems in daily life. In addition to meaningful learning, students also need learning that can improve critical thinking skills. As stated by Facione (2015) that critical skills as cognitive skills are an intellectual process that each individual has to be able to interpret, analyze, evaluate, inferate, explain and control oneself in thinking in solving a problem.

According to Mainali (2011), critical thinking skills are essential skills needed in the 21<sup>st</sup> century. Critical thinking skills can be trained in students through student-centered learning. Students' critical thinking skills are very important in the learning process, not just memorizing material that they do not necessarily understand. In addition, according to Moore & Parker (2024), the ability to think critically can affect students' learning outcomes, if students' thinking skills are low, it will also have an impact on their learning outcomes. This is strengthened by Bakhruddin (2021) which states that the ability to think critically in the learning process can make learning retention higher, learners more active, knowledge gained more broadly, able to sort out the right information or learning resources. Therefore, teachers must choose learning media and strategies that can improve students' thinking skills.

Efforts that can be made to overcome these problems are by providing teaching materials in the

form of teaching modules that are innovative and able to attract the attention of students, one of which is by developing problem-based teaching modules. According to Kosasih (2021), teaching modules are something that is used by teachers and students to facilitate the learning process which is seen as improving students' knowledge and experience according to the demands of the curriculum as a learning implementation. According to Sari et al. (2022), a good teaching module is a teaching material that is systematically arranged commensurate with the characteristics of the students, focuses on the students' environmental experience, is easy to understand, and is in accordance with the demands of the curriculum.

In problem-based learning, students are first presented with physical problems that students can observe in daily life and then students are responsible for investigating these problems. The relationship between the material and its environment can foster meaning in learning so that it can improve critical thinking skills (Ani, 2013).

This is in line with the results of research conducted by Fitri (2015) entitled The development of problem-based physics modules to improve the critical thinking skills of high school students on dynamic fluid materials with the results of the research that students' critical thinking skills after participating in the learning process using problem-based physics modules on dynamic fluid materials have improved so that a conclusion can be drawn that the use of problem-based learning modules can help students understand the material.

The development of this module is developed based on the needs of students in the learning process. Referring to the problems or problems faced by students, a module is needed that can help students understand concepts, especially in physics materials. Therefore, it is necessary to develop a problem-based physics teaching module to support students in learning independently or in groups and improve students' critical thinking skills.

## Method

The type of research method used is development research. The development research in question is research conducted to produce independent curriculum teaching modules problem-based learning. This development research uses a 4-D model (Four-D Model) developed by Thiagarajan (1974) covers the definition stage (Defined), Planning (Design), Development (Develop), and Deployment (Disseminated).

### *Development Procedure*

Procedure for developing learning tools in this case the development of independent curriculum teaching modules problem-based learning used in this study is the development of a 4-D model developed by Thiagarajan (1974) which consists of four stages. The four stages are the definition (defines), planning (Design), development (Development), and dispersal (Dissemination). This teaching module will be developed to be tailored to learning-based learning Problem Based Learning (PBL).

### *Definition Stage*

The definition stages in this study include five main steps, namely initial analysis, student analysis, task analysis, concept/material analysis and learning objective analysis. This is done to find out an overview of the physics learning process at SMA Negeri 3 Makassar, determine the fundamental problems faced by students, examine the characteristics of students, identify, detail, and systematically compile the relevant main parts that will be studied by students in physics subjects in class X.4 of SMA Negeri 3 Makassar and the selection of materials developed with problem-based learning, and determine learning objectives that are in accordance with the material to be studied. This analysis was obtained from the results of observations and interviews with 4 physics teachers at SMA Negeri 3 Makassar regarding the implementation of learning, the suitability of learning modules and obstacles in learning physics.

### *Planning Stage*

This stage is carried out to make modules in accordance with the content framework of the curriculum and material analysis results. The purpose of this stage is to prepare a prototype of a physics learning module. The design of this stage includes the creation of physics modules, module cover planning, preparation of learning outcome specifications and learning objectives, preparation of materials, and preparation of module feasibility test instruments.

### *Development Stage*

The Development Stage is the activity of making designs into products and testing product validation (Sugiyono, 2016). After designing the module, it is then proceeded to the development stage. The development stage is carried out by testing the content and readability of the module to the experts involved at the time of design validation and students who use the module. The test results are then used for revision so that the module has truly met the needs of the user. The steps taken at this stage include validation by experts, design revisions, and limited trials. After the module trial, the

next module asks for the response of students and teachers to the problem-based physics teaching module that has been developed through a teacher and student response questionnaire as well as a test of students' critical thinking skills.

*Stages of Deployment*

This step is the final stage of development research. The dissemination stage is carried out to disseminate the

module products that have been developed. The dissemination stage contains activities to disseminate products that have been tested for use by others (Sugiyono, 2019). In the distribution of modules, the development results are carried out on a limited basis, namely given to teachers/schools where the research is conducted.

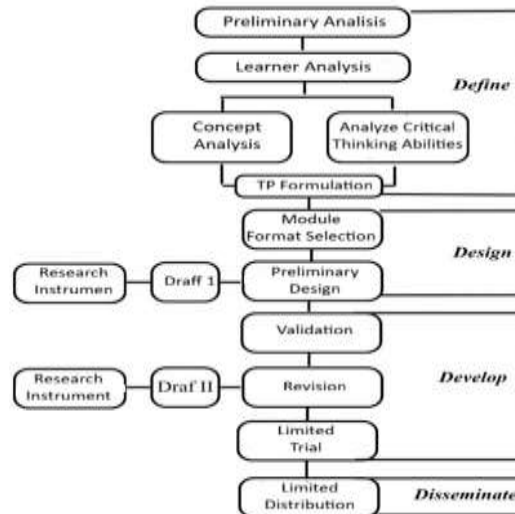


Figure 1. Development model of 4-D learning tools by Thiagarajan and Semmel

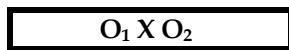


Figure 2. Initial design of the Science Literacy-Based Physics Teaching Module (Draft I): (a) Cover; (b). Preface; (c) Table of Contents (d) Discussion Materials; (e) Glossary; (f) Bibliography

*Research Subject*

The sample used in this study is class X of SMA Negeri 3 Makassar for the 2024/2025 Academic Year. The subject of the product trial related to the development of the independent problem-based curriculum physics teaching module is class X.4 with 38 people selected by purposive sampling technique. In addition, the researcher also took a sample of practitioners of physics subjects at SMA Negeri 3 Makassar City as many as 4 people and 6 physics teachers from other schools who are members of the MGMP Physics of Makassar City High School so that there are 10 teacher practitioners as research subjects.

The trial design used is "one group pre-test and post-test Design". In this design, observation is carried out twice, namely before the experiment (O<sub>1</sub>) called pre-test and after experiment (O<sub>2</sub>) is called post-test. The design of this trial is described as follows.



**Figure 3.** Research trial design

Description:

X : Treatment (independent variable)

O1: Pre-test scores (before being given problem-based physics modules)

O2: Post-test scores (after being given problem-based physics modules)

*Data Analysis Techniques*

Data from the validation results of the problem-based physics teaching module, validation the practitioner assessment questionnaire and the validation of the critical thinking ability test were analyzed by considering input, comments, and suggestions from experts. The analysis used to determine the level of relevance by three experts used the content validity coefficient (Aiken's V). Aiken's V formula was used to calculate the content validity coefficient based on the results of each expert's assessment of an item using equations (Azwar, 2012).

$$V = \frac{\sum s}{n(c - 1)} \tag{1}$$

$$s = (r - l_0) \tag{2}$$

Descriptions:

V = Aiken's validity index

s = The score assigned by each rater minus the lowest score in the category used

l<sub>0</sub> = Lowest validity rating number

c = Highest validity rating number

r = The number given by the assessor

n = Number of raters

Aiken's test requirement, after the calculation is done, if  $V \geq 0.4$ , then the expert agreement index is said to be valid. The analysis of practitioner and student assessments in the form of a questionnaire using the Likert scale presented 36 positive and negative statements for practitioners and 30 positive and negative statements for students. In answering the statement item, you can select answers that include "4 (strongly agree)", "3 (agree)", "2 (disagree)", "1 (strongly disagree)". The assessment data of practitioners and students on the problem-based physics learning module listed in the questionnaire sheet was analyzed using the following equations:

$$\text{Introduce yourself} = \frac{\text{Total score of each item}}{\text{Ideal score (maximum)}} \times 100\% \tag{3}$$

The analysis used to calculate the percentage of student completeness according to Arikunto (2010) is as follows:

$$\text{PPS} = \frac{\text{Obtained score}}{\text{Maximum score}} \times 100\% \tag{4}$$

Furthermore, to find out the improvement of students' critical thinking skills, it was carried out using gain score analysis to see how much the students' critical thinking skills have improved. Gain score is the difference between pretest and posttest scores. The results will show an improvement in students' critical thinking skills.

According to Sundaya (2014) the calculation of *gain score* is carried out in the following way:

$$\text{Normalized Gain (g)} = \frac{X_{\text{Pretest}} - X_{\text{Posttest}}}{X_{\text{Max}} - X_{\text{Pretest}}} \tag{5}$$

Description:

g : Normalized gain score

X<sub>Pretest</sub> : Pretest score (initial test)

X<sub>Posttest</sub> : Posttest score (final test)

X<sub>Max</sub> : Maximum score

**Result and Discussion**

*Learning Module Research Results*

The results of the analysis of the validation of the development of the learning module include the results of the validation of the problem-based physics teaching module, the results of the validation of the practitioners' response questionnaire sheet to the independent curriculum physics teaching module based on the problem-based curriculum, the results of the validation of the questionnaire sheet of students' responses to the independent curriculum physics teaching module and the results of the validation of the critical thinking ability test.

*Results of Validation of Problem-Based Physics Teaching Module*

The aspect of assessing the content of the physics teaching module of the independent curriculum based on problems includes content aspects, presentation aspects, language aspects and graphic aspects. The results of the validation of the problem-based teaching module can be seen in the table below.

**Table 1.** Analysis of the validity of the content of problem-based physics teaching modules

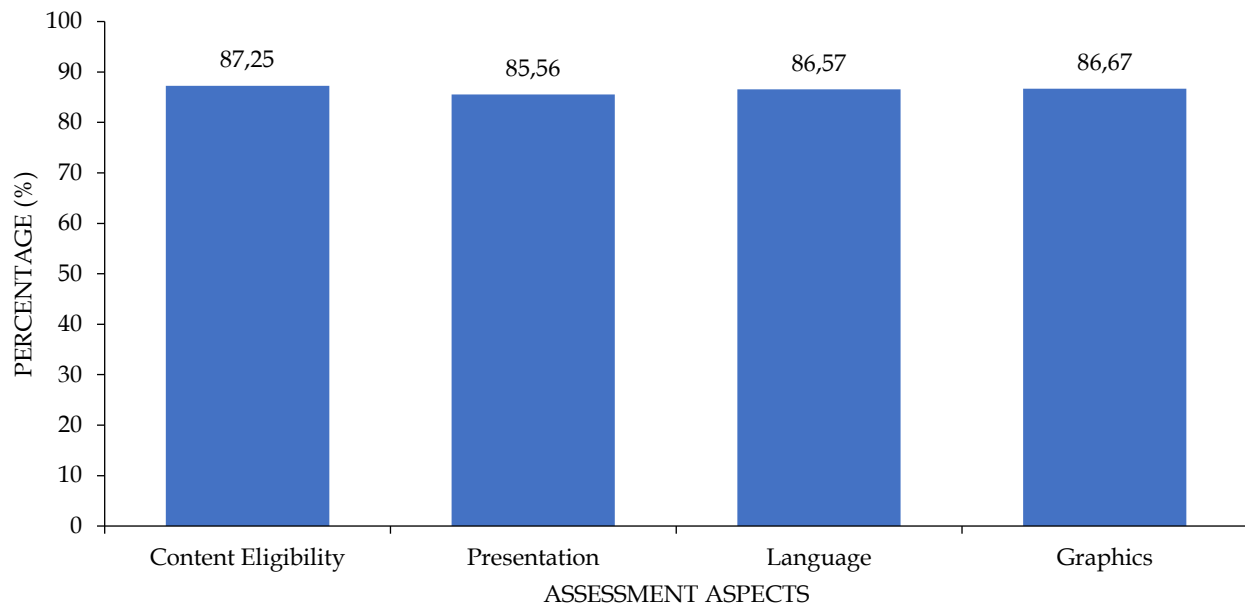
Aspects	Number of Validation Points	V	Categories
Contents	14.11	0.83	Valid
Presentation	12.94	0.80	Valid
Language	14.77	0.81	Valid
Graphic	12.33	0.82	Valid

Source: Processed Primary Data (2025)

The feasibility aspect of the content was obtained by the average expert agreement index (V) of 0.83 in the valid criteria, the presentation aspect obtained by the average expert agreement index (V) of 0.8 in the valid

criteria, the language aspect obtained by the average expert agreement index (V) of 0.81 in the valid criteria, and the graphic aspect obtained by the average expert agreement index (V) of 0.82 in the valid criteria. The third percentage of validators for the independent curriculum physics teaching module is problem-based which can be illustrated in the percentage graph in Figure 4.

The expert assessment of the problem-based physics teaching module developed came to the same conclusion, namely that it can be used with minor revisions. Some of the corrections and suggestions given by experts include: adding sources to the image; using images derived from the surrounding environment; using problem-based learning indicators in learning activities and student worksheets; and pay attention to the use of language, punctuation and writing that are appropriate to EYD. After revisions based on corrections and suggestions from three expert validators on the problem-based physics teaching module, the teaching module was declared suitable for use in the limited trial stage.



**Figure 4.** Percentage of feasibility of component aspects of the independent curriculum teaching module of the independent curriculum

*Results of Assessment of Teacher Practitioner Responses to the Independent Curriculum Physics Teaching Module Problem-Based*

The data on teacher practitioner scores was obtained from the results of the assessment of teacher practitioner questionnaires on the problem-based physics teaching module given at the dissemination stage. This assessment was carried out by physics teachers at SMA Negeri 3 Makassar and physics teachers from other high schools who are members of the

Makassar City Physics MGMP community. The practitioner assessment questionnaire sheet consists of 35 statements containing 4 aspects, namely the feasibility of content, the feasibility of presentation, the feasibility of language, and the feasibility of graphics. Then it was assessed using the Likert scale with a score range of 1 to 4 according to the specified criteria. The results of the assessment scores from 10 teachers are grouped according to the criteria in Table 2.

**Table 2.** Practitioner assessment score percentage criteria

Criterion Interval (%)	Criteria
81-100	Excellent
61-80	Good
41-60	Medium
21-40	Less
0-20	Very less

Sources: Riduwan (2010)

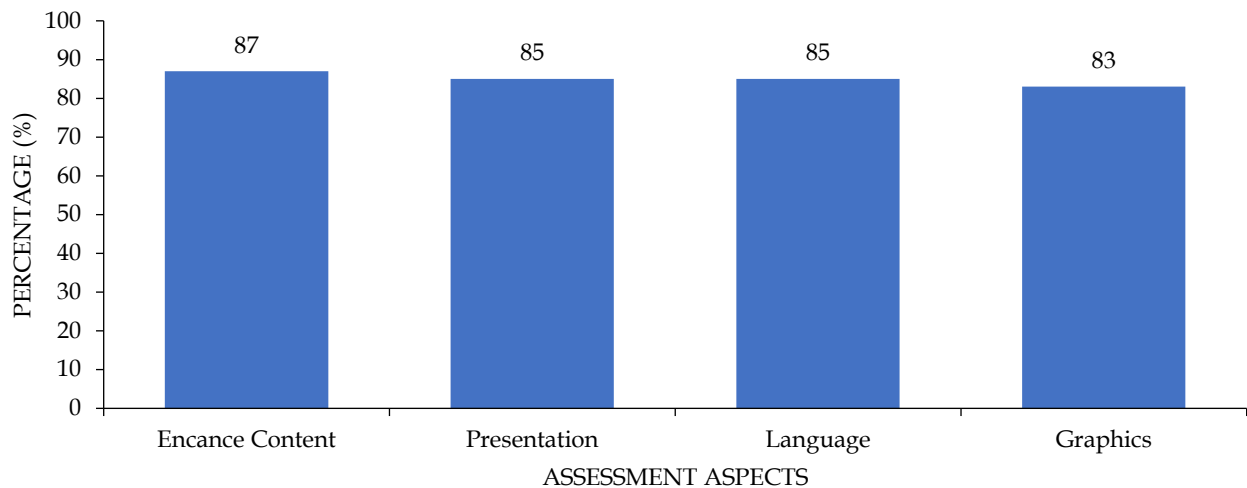
The results of the analysis of practitioners' assessments of the problem-based physics teaching module can be seen in Table 3.

**Table 3.** Results of practitioner assessment of problem-based physics teaching module

Aspects	Total Score Procurement	Percentage (%)	Criteria
Contents	384	87	Excellent
Presentation	271	85	Excellent
Language	546	83	Excellent
Graphic	231	83	Excellent

Source: Processed Primary Data (2025)

In the material/content aspect, the total score was 348 with a percentage of 87%, in the presentation aspect, the total score was 271 with a percentage of 85%, in the language aspect, the total score was 546 with a percentage of 85%, and in the graphography aspect, the total score was 231 with a percentage of 83%. The results of the analysis of teachers' responses to the problem-based physics teaching module are depicted in the form of a graph can be seen in Figure 5.



**Figure 5.** Teacher practitioner assessment score percentage for the independent curriculum physics teaching module problem-based

The assessment of teacher practitioners of the problem-based independent curriculum physics teaching module in the picture can be seen that the teachers give assessments on each aspect with an average of above 80% with the category of very good, in other words that the problem-based physics teaching module that has been developed can be used by for classroom learning.

*Results of Assessment of Student Practitioner Responses to the Development of Problem-Based Physics Teaching Modules*

The purpose of analyzing student response data to the problem-based physics teaching module is to see

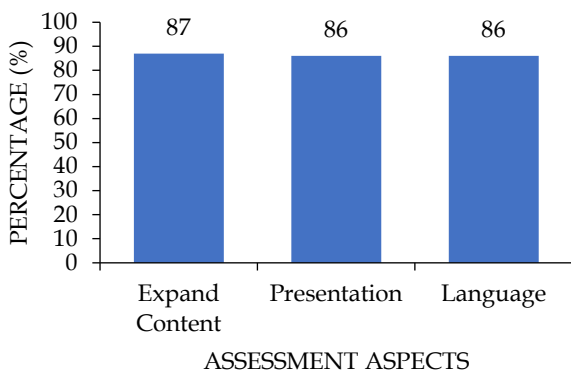
how student practitioners respond to the problem-based independent curriculum physics teaching module that has been used during learning. Score data was obtained from the results of the assessment of the student practitioner questionnaire on the problem-based physics teaching module given at the deployment stage. Based on the research of students' responses to the problem-based physics teaching module that has been developed, it is shown in Table 4.

**Table 4.** Results of student assessment of the problem-based physics teaching module

Aspects	Total Score Procurement	Percentage (%)	Criteria
Contents	1320	87	Excellent
Presentation	781	86	Excellent
Language	1179	86	Excellent

Source: Processed Primary Data (2025)

Based on Table 4, in terms of the material/content aspect, the total score was 1320 with a percentage of 87%, in the presentation aspect, the total score was 781 with a percentage of 86%, in the language aspect, the total score was 1179 with a percentage of 86%, The results of the analysis of students' responses to the problem-based physics teaching module are depicted in the form of a bar diagram can be seen in the following Figure 6.



**Figure 6.** Percentage of student practitioner assessment score for problem-based physics teaching module

The percentage of the student's practitioner assessment score on the problem-based physics teaching module can be seen that students give assessments on each aspect with an average of above 80% with the very good category, in other words that the problem-based physics teaching module that has been developed can be used by for classroom learning.

*The Effectiveness of Problem-Based Physics Teaching Modules in Fostering Critical Thinking Skills*

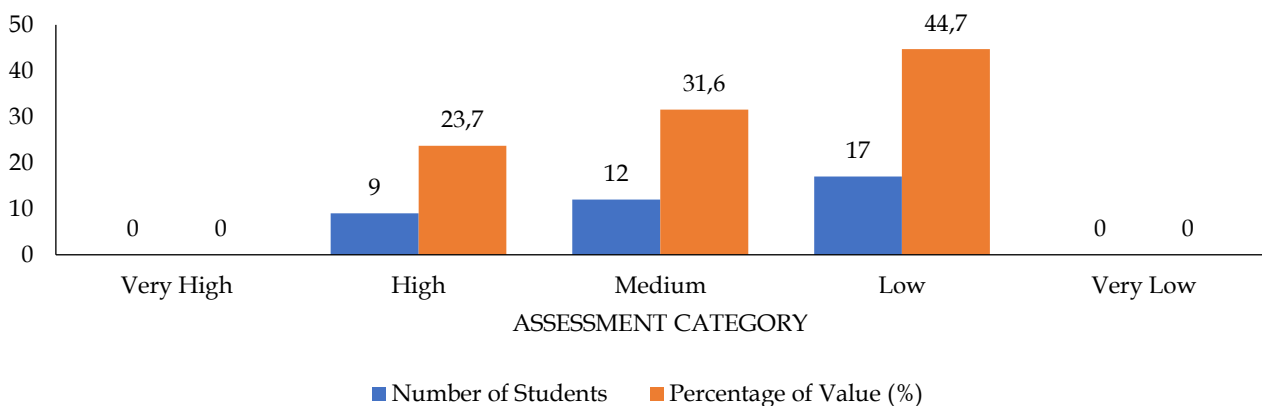
The effectiveness of the problem-based physics teaching module developed can be measured by assessing students' critical thinking skills after being given a problem-based physics teaching module. The assessment is given using a ten-item (10) test of essay choice questions. The results of the analysis of students' critical thinking ability tests before and after being given the problem-based physics teaching module that has been developed. The results of the analysis of students' critical thinking skills test before being given a problem-based physics teaching module can be seen in Table 5.

**Table 5.** Pretest score of critical thinking ability for Class X.4 students of SMA Negeri 3 Makassar

Interval Criteria	Categories	Students	Percentage of Value (%)
81-100	Very High	0	0
61-80	Height	9	23.7
41-60	Medium	12	31.6
21-40	Low	17	44.7
0-21	Very Low	0	0
Quantity		38	100

Source: Processed Primary Data (2025)

The pretest scores of students' critical thinking ability above show that the number of students who obtained the very high score category was 0 people with a percentage of 0%, 9 students who obtained the high category with a percentage of 23.7%, students who obtained the medium category were 12 people with a percentage of 31.6%, students who obtained the low category were 17 people with a percentage of 44.7%, students who obtained a very low category of 0 people with a percentage of 0% The results of the analysis of the pretest scores of Critical Thinking ability students in Class X.4 of SMA Negeri 3 Makassar can be seen in the Figure 7.



**Figure 7.** Percentage of pretest scores for critical thinking ability of Class X.4 students of SMA Negeri 3 Makassar

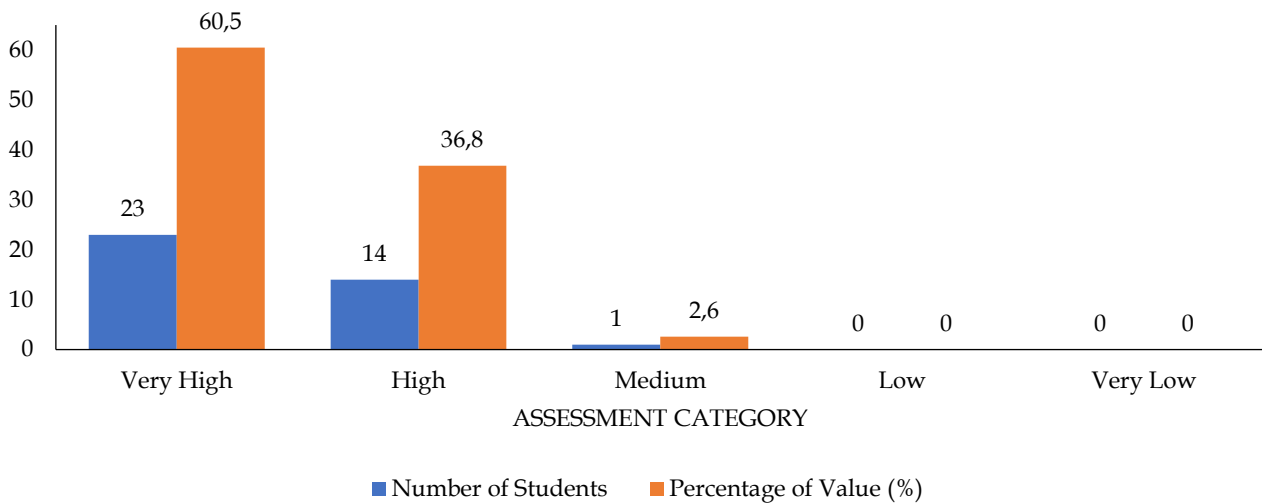
The results of the analysis of students' critical thinking ability tests after being given a problem-based physics teaching module can be seen in Table 6.

**Table 6.** Posttest score of critical thinking ability of Class X.4 students of SMA Negeri 3 Makassar

Interval Criteria	Categories	Number of Students	Percentage of Value (%)
81-100	Very High	23	60.5
61-80	High	14	36.8
41-60	Medium	1	2.6
21-40	Low	0	0
0-21	Very Low	0	0
<b>Quantity</b>		<b>38</b>	<b>100</b>

Source: Processed Primary Data (2025)

Based on the Table 6, it shows that the number of students who obtained the very high grade category was 23 people with a percentage of 60.5%, students who obtained the high category were 14 people with a percentage of 36.8%, students who obtained the medium category were 1 person with a percentage of 2.6%, and



**Figure 8.** Score percentage of critical thinking ability posttest for students of Class X.4 SMA Negeri 3 Makassar

**Table 7.** Percentage of estimated effectiveness of gain score critical thinking ability of Class X.4 students of SMA Negeri 3 Makassar

Interval (%)	Categories	Frequency	Percentage (%)
$g \geq 56$	Effective	33	86.84
$g \leq 55$	Ineffective	5	13.15
<b>Quantity</b>		<b>38</b>	<b>100</b>

Source: Processed Primary Data (2025)

Based on Table 7, it is known that as many as 33 students are in the effective criteria with a percentage of 86.84%, and there are 5 students who are in the ineffective criteria with a percentage of 13.15%. It can be concluded that there is an increase in the critical thinking skills of students in class X.4 of SMA Negeri 3 Makassar

there were no students who obtained the low and very low category. The results of the analysis of the pretest scores of Critical Thinking ability of Class X.4 students of SMA Negeri 3 Makassar can be seen in Figure 8.

Furthermore, an analysis was carried out to improve students' critical thinking skills using N-gain pretest and posttest data. The results of the students' pretest and post-test were analyzed with N-gain to see the improvement of students' critical thinking skills before and after being given the problem-based physics teaching module. The results of the N-gain analysis are presented in the form of a line diagram as shown in Figure 8, the results are obtained that most of the students' critical thinking skills have improved from the test before being given the problem-based physics module with the test after being given the problem-based physics module. However, there is 1 student with the same pre-test and post-test categories, which is moderate, this means that there is an increase in critical thinking skills. This can also be seen in Table 7.

and the problem-based physics teaching module can be said to be effective in the learning process. Furthermore, the score of the improvement test of students' analytical thinking ability is presented in the form of a bar diagram in Figure 9.

Based on Figure 9, it is known that there is an increase in critical thinking skills with different criteria. The results of the analysis showed that as many as 33 students experienced an increase in the high criteria, as many as 3 students were in the medium criteria and there were 2 people who experienced an increase in the low category, and there were no students who experienced a decrease. Overall, from the results of the analysis of improving students' critical thinking skills, an average N-gain value of 0.84 can be obtained, which

is in the high category. So that it can be concluded that there is an increase in the critical thinking skills of students in class X.4 of SMA Negeri 3 Makassar. These

results show that the use of the independent problem-based curriculum physics teaching module is effective to be used to improve students' thinking skills.

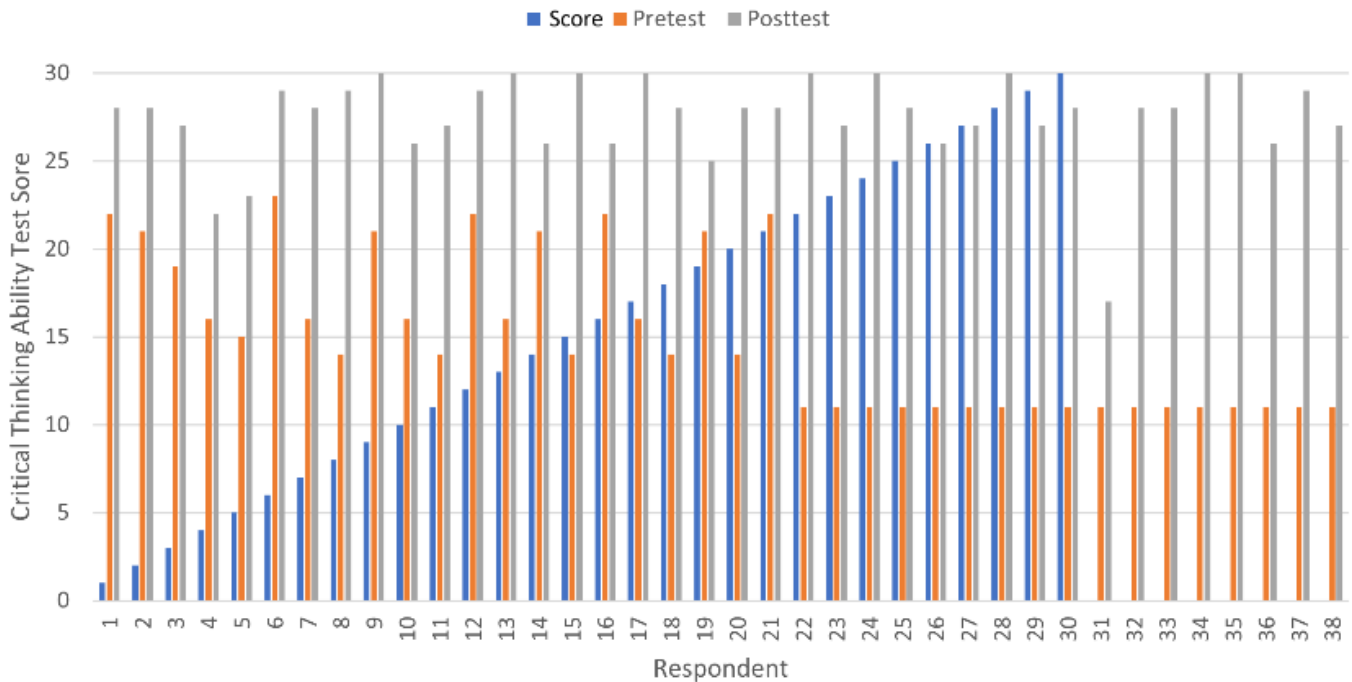


Figure 9. Pre-test and post-test diagram of critical thinking ability

Discussion

Results of Validity of Problem-Based Physics Teaching Module Content

The results of expert validation from three (3) experts on average stated that the problem-based physics teaching module developed can be used with minor revisions. The results of the validation analysis showed that the problem-based physics teaching module was in the valid category. Furthermore, based on the development carried out, the physics teaching module is implemented as a material for the evaluation of the development that has been carried out. This can be seen in practicality based on the responses of teachers and students. In addition to practicality, to see the feasibility of the development that has been carried out can be seen from the level of effectiveness. The effectiveness of this problem-based teaching module was obtained by testing students' critical thinking skills.

Problem-based physics teaching modules that have been declared valid, practical and effective can be used by students in learning independently or in groups. The physics teaching module is made systematically and uses language that is easy to understand and presents a problem related to daily life so that students can learn independently without the help of teachers. The physics teaching module is structured based on problem-based learning (PBL) or problem-based learning that emphasizes group learning.

Validity of Problem-Based Physics Teaching Modules

Aspects that need to be considered in module validation are the format of the components, content and language. Before the developed product is tested, it must go through the validation stage. The problem-based physics teaching module is validated by three Physics lecturers at Makassar State University who are competent in the field of modules with the aim of assessing and advising on the developed products so that later they can produce valid and good problem-based physics teaching modules.

The three validators fill in the validation sheet that has been given with a value range of 1 to 4 and then the results are analyzed using Aiken's index. The results of the three validators on the problem-based physics teaching module based on format and component aspects, content aspects and language aspects were then analyzed using the Aiken's V index formula, a value that was in the valid category and could be used after going through the revision stage, namely input and suggestions from the validator. This is in line with the results of research conducted by Hudha et al. (2017). The results of the study show that the feasibility of problem-based physics learning modules according to material experts, media experts, and high school physics teachers for the content, presentation, and language components has very valid criteria.

### *Practitioner Assessment of the Problem-Based Physics Teaching Module*

The teacher practitioner assesses the content of the material which is assessed from the suitability of the physics material with the indicators of competency achievement, learning objectives in class X. Then in the component of the composition of the material, the practitioner gives an assessment on the systematic consistency of the presentation of the material in the problem-based physics teaching module, in the language component an assessment of how to use communicative and interactive language without causing double meaning. The practitioner provides an assessment of the formative test instruments contained in the module, whether the available formative tests can measure the achievement of students' competencies. Furthermore, the teacher practitioner provides an assessment of the suitability of the content of physics material that is integrated with problem-based learning. Student practitioners provide assessments of problem-based physics modules. The aspect that is assessed is the efficiency of using modules in learning, then the use and benefits of the modules that have been developed.

In general, the practitioners' response scores to the implementation of the problem-based physics teaching module are in the very good category, so it can be concluded that the independent problem-based curriculum physics teaching module that has been developed can help teachers and students in the physics learning process to understand physics concepts contextually and more easily and provide convenience to improve students' critical thinking skills. The results of practitioners' responses to the problem-based physics teaching module show that the module supports the learning process of students, making it easier for students to understand physics concepts. Based on the analysis of the responses of teachers and students, a conclusion can be drawn that the problem-based physics teaching module is in the very good category. This is in line with research conducted by Fitri (2015) with the results of the research, it was obtained that the quality of the physics module was based on problems in the business and energy materials developed in the good category.

### *Effectiveness of Problem-Based Physics Teaching Modules*

The most important aspect of effectiveness is knowing the level or degree of application of the product (Rochmad, 2012). According to Hake (1999), the effectiveness of a teaching material is usually seen from the potential effects in the form of the quality of learning outcomes, attitudes and motivation of students.

The effectiveness of this problem-based teaching module is shown in the assessment of students' critical thinking ability tests. The test was given as many as 10

essay questions. The questions were distributed to 38 students in class X.4 of SMA Negeri 3 Makassar. Students' critical thinking ability tests are given before (pretest) and after (posttest) the use of problem-based physics teaching modules. The test was carried out to see the improvement of critical thinking skills of students in class X.4.

The results of data analysis obtained the critical thinking ability score of students before being given the problem-based physics teaching module (pretest), namely in the high category as many as 9 students with a score percentage of 23.7%, medium category as many as 12 people with a score percentage of 31.6%. and in the low category as many as 17 people with a score percentage of 44.7%. The results of the data analysis obtained the critical thinking ability score of students after being given a problem-based physics teaching module (posttest), namely in the very high category as many as 23 people with a score percentage of 60.5%, students in the high category as many as 14 people with a percentage of 36.8% and there were students in the low category as many as 1 person with a percentage of 2.6%.

Furthermore, an N-gain analysis was carried out to see an improvement in students' critical thinking skills before and after the use of the problem-based independent curriculum physics teaching module. The results of the analysis were obtained in the high category as many as 33 people with a score percentage of 86.84%, students in the medium category as many as 3 people with a percentage of 7.89% and there were 2 students in the low category with a percentage of 5.26%. Based on the results of the analysis, an N-gain score was obtained with an average of 0.84, which means that there is an increase in students' critical thinking skills in the high category.

This means that the physics teaching module of the curriculum is independent problem-based learning to improve students' critical thinking skills is said to be effective. This is in line with research conducted by Fitri (2015) with the results of the study, it was obtained that the critical thinking skills of students in class X after using the problem-based physics teaching module experienced an average increase in scores of 50%.

## **Conclusion**

Based on the results of research and limited trials of the problem-based physics teaching module in class X.4 SMA Negeri 3 Makassar, the conclusion was obtained: the physics teaching module of the independent problem-based curriculum to improve students' critical thinking skills developed based on expert assessments was declared valid and feasible to use with minor revisions; the physics teaching module of the

independent problem-based curriculum to improve students' critical thinking skills reviewed from the teacher's assessment is in the very good category; the physics teaching module of the independent problem-based curriculum to improve students' critical thinking skills reviewed from the assessment of students is in the effective category; the problem-based physics teaching module on students' critical thinking skills analyzed using N-gain is in the High category.

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#### Author Contributions

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There were no conflicts of interest in this study.

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