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Development of Discovery-Based Physics Teaching Modules to Improve Critical Thinking Skills

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Abstract

This study is a development research that aims to describe the feasibility of discovery-based Physics teaching modules, practitioner's assessment on discovery-based Physics teaching modules, improvement of critical thinking skill tests, and to produce discovery-based Physics teaching modules. The method used to achieve this goal is R&D using a 4D model. The research trial subjects were 34 students of Class X.2 natural sciences (IPA) at State Senior High School (SMAN) 9 Gowa. The research instruments used discovery-based physics teaching module validation sheets, practitioner assessment questionnaires, and critical thinking skills test instruments. Based on the results of data analysis, the conclusions obtained are: 1) The discovery-based Physics teaching module was declared valid and suitable for use with slight revisions; 2) The discovery-based Physics teaching module in terms of practitioner responses is that the Physics subject teacher is in the practical category; 3) The effectiveness of the discovery-based Physics teaching module in terms of students' critical thinking skills obtained average N-Gain percentage value is 56% and was in the effective category. Students experience increased critical thinking skills on indicators of interpretation, analysis, and inference. This can be interpreted as saying that the discovery-based Physics teaching module developed is effective in improving students' critical thinking skills.

Keywords: 21st century learning, critical thinking skills, discovery learning, scientific problem solving, student-centered learning

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1. Introduction

Modern learning approaches highlight the importance of both knowledge and skills, which are crucial in many areas of life. 21st century learning emphasizes knowledge and skills. Skills are an important component needed in various fields in life. 21st century learning is a transition from teacher centered learning to student centered learning, in other words, the learning process directs students to be able to dominate learning more actively and should show learning concepts that are able to build students' skills. The skills in question include logical, analytical, critical, and creative thinking skills. These skills are important for students to connect concepts and materials so that they are able to understand and solve problems in the classroom (Lestari et al., 2018). According to Maulidia et al. (2023) that the 21st century skills that students must have are critical thinking skills.

Critical thinking skills include interpretation, analysis, evaluation, inference, explanation, and self-regulation (Darwis et al., 2020, p. 121). An individual's ability to think critically can improve the quality of individual thinking to analyze, assess, and reconstruct what he thinks to solve problems (Amalia et al., 2023).

Students' critical thinking skills are useful in stimulating cognitive reasoning and building knowledge (Adeyemi, 2012), increasing students' learning motivation (Cholisoh et al, 2015), students' scientific attitudes (Tuan, Nurazidawati, & Osman 2010) and students' science process skills (Nugraha, 2017).

Critical thinking skills are an essential ability in education, especially in science subjects such as physics (Amelia & Muhammad, 2024). Physics learning is one of the lessons at school that provides knowledge about the universe with the aim of training in thinking and reasoning. Physics learning is equal to skill development and success is measured by a number of problems that students solve correctly (Winarti et al., 2021). The difficulty of most applied problems in Physics lies in knowing how to clarify the problem so that the problem can be solved. Critical thinking in Physics learning should be the main goal for students to solve problems so that the knowledge gained is not accompanied by erroneous reasoning (Khaeruddin et al., 2018). Sugiarti & Dwikoranto (2021) stated that, in learning Physics, higher critical thinking skills are needed.

Critical thinking skills in physics learning are considered important for students because physics is not only about understanding theoretical concepts, but also about applying scientific principles to solve real problems (Pratiwi et al., 2019). According to Siwardani et al. (2015) revealed that critical thinking skills are very important considering the nature of physics which requires a deep understanding of concepts and the ability to connect theory with practical applications in everyday life.

Critical thinking skills in the current 21st century education era can be realized through the implementation of the independent curriculum promoted by the government. The independent curriculum is a forum for developing students' critical and analytical thinking skills. In addition, in the independent curriculum, the active involvement of students is also the main focus in learning (Kurniawan et al., 2024).

The concept of independent learning developed as a curriculum has relevance to the 21st century learning model, which is more oriented towards the learning needs of students (student center). Learning on an independent curriculum will produce students who can discuss with friends and teachers, learn outside the classroom, form independent, civilized characters, and have critical thinking competencies (Khusna et al, 2023).

Annam et al. (2024) revealed in their research, the development of critical thinking skills in the application of the independent curriculum found that students' critical thinking skills increased significantly after the application of the independent curriculum from the previous 75% increased to 85% with a good category. Then followed by cycle II which had a higher percentage than cycle I, namely with a higher percentage of 85% and had a very good category. Likewise, research conducted by Jufriadi et al. (2022), found that the implementation of an independent curriculum can provide significant results for improving 21st century skills, one of which is critical thinking.

One of the supports for the implementation of an independent curriculum is the development of teaching modules. Teaching modules are learning tools or learning designs based on the curriculum that are applied with the aim of achieving predetermined competency standards. Teaching modules have a major role to support teachers in designing learning. In the preparation of learning tools that play an important role are teachers, teachers are honed in thinking skills to be able to innovate in teaching modules (Salsabilla et al., 2023).

According to the learning and assessment guidelines, the main purpose of developing teaching modules is to develop teaching tools. Teaching tools serve to guide educators to carry out learning by meeting several criteria that are in accordance with the needs of learner characteristics. Teaching modules are very important in the learning process for teachers and students. Indeed, teachers will have difficulty increasing the effectiveness of teaching if it is not juxtaposed with a complete teaching module. This applies to learners, because what is delivered by the teacher is not systematic.

The independent curriculum includes several forms of educational strategies that direct critical thinking, one of which can be realized through discovery (Kurniawan et al., 2020). Discovery learning is one of the lessons that is in accordance with the characteristics of Physics learning. Discovery according to Darmawan et al (2019) is a learning method that encourages students to ask questions and draw conclusions from general principles. This learning model consists of a series of activity stages (phases) organized in such a way as to form a continuity so that learners can master the competencies that must be achieved in learning. This can be done according to Arafah (2020, p. 148) by the way students play an active role in learning. Discovery learning leads learners to learn independently to gain their knowledge through the learning activities they do, identifying the problems given, then finding information and proving it. Furthermore, students can draw conclusions from the findings.

Based on the description above, in this study researchers aim to develop and produce discovery-based Physics teaching modules that meet development criteria, namely valid and practical, and analyze the effectiveness of using discovery-based Physics teaching modules in improving students' critical thinking skills.

According to Nieveen in Wulandari & Suliyanah (2019, p. 550) that the quality of the teaching module developed must meet the criteria of valid, practical, and effective. The validity of the discovery-based Physics teaching module developed is seen from the results of the content validity obtained. Content validity refers to the content of the product, carried out aims to examine the extent to which the content of the module can measure what should be measured, in this study the teaching modules developed should be able to cover the measurement aspects of validity, in accordance with the content of the material developed, and be able to improve students' critical thinking skills.

The development of discovery-based Physics teaching modules is expected to achieve the three development criteria described above, namely validity, practical, and effectiveness. As research conducted by Wangi et al. (2022) who developed discovery learning-based physics learning tools obtained development results that met the validity and practical criteria with very valid and very feasible categories, and the effectiveness was in the category of effective enough to improve students' critical thinking skills. This is in line with research conducted by Anggreni & Yohandri (2022) who developed a discovery learning-based e-book integrated with 4C skills for high school Physics learning resulting in development validity that meets valid criteria, the results of user practicality by teachers and students are in the practical and very practical categories, and the effectiveness of using e-books is obtained to be able to improve 4C skills, one of which is critical thinking.

2. Method

This research is a research and development (R&D) with the 4D model which consists of four research stages, namely defining, designing, developing, and disseminating. The 4D research procedure is systematically depicted in the following chart.

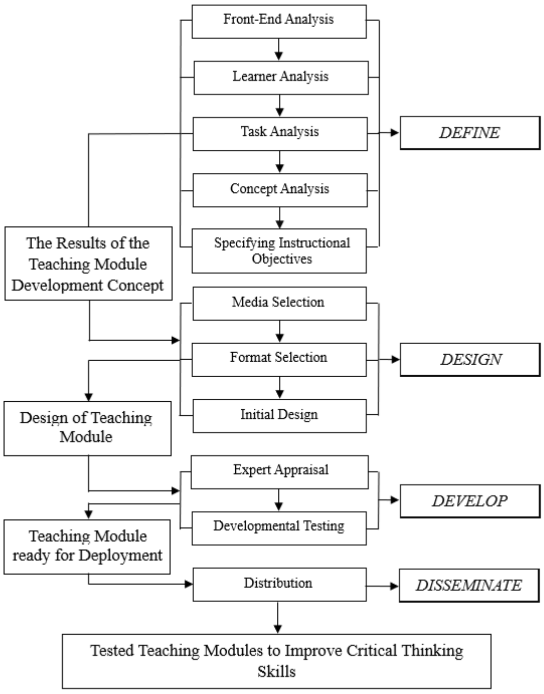


Figure 1. Modification of Module Development Stage Using 4D Model

This study used research instruments in the form of a discovery-based Physics teaching module validation sheet, practitioner assessment questionnaire, and critical thinking skills test. The test subjects in this study were students of class X.2 Natural Sciences (IPA) State Senior High School (SMAN) 9 Gowa, totaling 34 students. Students were given the test twice using Pretest-Posttest Design.

$$O_1 \qquad X \qquad O_2$$

Description:

O_1 : Pretest

X : Application of the developed teaching module

O_2 : Posttest

The analysis used to see the level of validity of teaching modules and instruments before stepping into the trial stage uses the validity index by Aiken which is formulated in Retnawati (2016, p. 18) as follows.

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

Description:

V : Index of rater agreement on item Validation

s : The score assigned to each rater/validator minus the lowest score used

n : Number of raters (validators)

c : The number of categories the rater can choose (validator)

The criteria used to decide that the teaching module meets the degree of validity is the validity value for all aspects $V \geq 0.4$.

Data analysis of practitioner responses obtained from the practitioner assessment questionnaire was analyzed using the following formula.

$$PRS = \frac{\sum A}{\sum B} \times 100\% \tag{2}$$

Description:

PRS : Percentage of the number of practitioners who responded to the categories stated in the instrument

$\sum A$: Total score obtained by each category stated in the questionnaire.

$\sum B$: The maximum score of the categories that responding to the questionnaire

Based on the percentage value obtained, it is then categorized according to the criteria for the percentage of practitioner assessment scores in Table 1.

Table 1. Interpretation Criteria for Practitioner Assessment Scores

Percentage Score (%)	Criteria
85 – 100	Very practical
70 – 84	Practical
50 – 69	Practical enough
50 – 54	Less Practical
0 – 49	Not Practical

The discovery-based Physics teaching module is said to be practical, if the percentage of practitioner assessment P ≥ 70% or is in the practical category.

Analysis of the effectiveness of discovery-based Physics teaching modules using pretest and posttest data. The scoring of the pretest and posttest was done dichotomously, where the correct answer was given a score of 1 and 0 for the wrong answer. The score results were then categorized based on the critical thinking skills score criteria in Table 2.

Table 2. The Criteria for Students' Critical Thinking Skills Score

Range	Criteria
$20 < X \leq 25$	Very good
$15 < X \leq 20$	Good
$10 < X \leq 15$	Medium
$5 < X \leq 10$	Less
$X \leq 5$	Very Less

The results of the critical thinking skills test were then analyzed using the n-gain formula (Normalized gain) formulated by Sukarelawan et al. (2024) in equation 3.

$$Normalized\ gain\ (g) = \frac{\text{Skor } Posttest - \text{Skor } Pretest}{\text{Skor Maksimum} - Pretest} \quad (3)$$

Based on the n-gain results obtained, it is then interpreted into Table 3 to determine the category of test improvement that occurs.

Table 3. Interpretation of the Gain Index

N-Gain Value	Criteria
$0{,}70 < g \leq 100$	High
$0{,}30 < g < 0{,}70$	Medium
$0{,}00 < g < 0{,}30$	Low
$g = 0{,}00$	No increase
$-1{,}00 \leq g < 0{,}00$	Decrease

The n-gain results are then made into percentages and adjusted based on the effectiveness criteria presented in Table 4.

Table 4. Gain Score Effectiveness Interpretation Category

Percentage (%)	Criteria
< 40	Not effective
40 – 45	Less effective
56 – 75	Effective
>76	Very effective

The discovery-based Physics teaching module is said to be effective, if the n-gain percentage ≥ 56% or is in the effective category.

3. Result and Discussion

a. Define

The defining stage is the initial process to define the reasons and objectives for developing teaching modules. In the defining stage, observations and interviews were conducted. Observations were made by directly visiting and observing the learning process in Class X.2 IPA, such as the methods and models used by teachers in teaching, teaching materials used, and observing students who were active and less active in the learning process. Observations were also made in the Physics laboratory to see the tools and materials that can support the Physics learning process and practicum. The interview was conducted to 1 Physics teacher in Class X IPA aimed at exploring information about how the critical thinking skills of students in Class X.2 IPA both through direct teacher assessment in class and the results of daily tests, as well as factors that cause some students to be less active in learning.

The defining results were obtained through five steps described in Table 5.

Table 5. Define Stage Results

Stages	Analysis Result
Front-end analysis	This step is carried out by means of interviews and observations aimed at digging up information related to Physics textbooks used, description of the Physics learning process in the classroom, student involvement in the learning process, and analysis of school infrastructure that can support Physics learning at school. • The observation of the textbook used by the teacher in teaching is an independent curriculum textbook entitled "Science of Nature" which contains Biology, Chemistry, and Physics materials. This shows that the material in the textbook does not focus on discussing Physics in detail. The material is presented in the form of discussions interspersed with learning activities for each chapter. In the textbook there are no sections that show activities that involve the process or active role of students, other than working on questions in learning activities. The textbook also does not present a description of the learning process based on the flow of the independent curriculum. • Learning takes place using conventional methods (lectures) interspersed with giving example problems and practice problems for each sub-material discussion. The problems given are problems with the same formulation as the example problems. The dominance of students who actively ask questions is students who are known to be good according to the teacher's explanation, while others tend to be silent and must be given a stimulus or appointed directly to ask or express opinions. • Based on the above, it can be said that the textbooks used have not been able to accommodate learner-centered learning so that students are less involved in learning or passive which has an impact on students' low motivation to learn Physics, and students are not accustomed to learning that trains thinking skills, such as critical thinking skills. • The results of the analysis of facilities and infrastructure obtained concluded that the state of facilities and infrastructure available is very qualified and can support Physics learning at school.
Learner analysis	Learner analysis aims to examine the characteristics of students which include the background of students and the initial physics knowledge of students obtained through interviews with students, as well as knowing the learning style of students obtained through a learning style questionnaire. • Students in Class X.2 IPA SMAN 9 Gowa totaled 34 people with a distribution of 16 female students and 18 male students. The average age of Class X.2 IPA students is in the age range of 15-16 years. According to Jean Piaget's theory, this age is able to think abstractly and develop hypotheses logically so that it is in line with the needs of 21st century skills that need to be improved, namely critical thinking skills. • The learning styles of students are obtained varied, including kinesthetic learning style 27%, visual learning style 44%, and auditory learning style 29%.
Concept analysis	This is done by determining the main concepts that will be taught to students and become the reference material for researchers to develop discovery-based Physics teaching modules. Based on the analysis of textbooks and learning styles of students, the material of climate change and global warming was chosen as suitable material to be developed in the development of this discovery-based Physics teaching module.
Task analysis	Aims to identify the competencies that learners will master. Task analysis or curriculum analysis is done to find out how the material will be developed in the module. Task analysis is carried out in the form of subject content analysis, which is formulated as an index to study and distribute the material or sub-material of climate change and global warming. The results of the analysis obtained there are two elements of learning outcomes that must be completed in Class X (Phase E) SMAN 9 Gowa. The two elements of learning outco-

Stages	Analysis Result
	mes will then be adjusted to the material of climate change and global warming that will be contained in the discovery-based Physics teaching module.
Specifying Instructional Objectives	Learning objectives are formulated based on the elements and learning outcomes that have been obtained from the task analysis stage.

b. Design

The design stage is the stage of obtaining a teaching module design or design based on data from the define stage. The data obtained previously are data that will be used as a guide in compiling the content of the teaching module according to the needs of the intended target learners. Based on the data in Table 5, it can be seen that the designed product contains climate change and global warming material for Phase E of the class X independent curriculum. As for the gaps obtained in the Front-end analysis. So, discovery was chosen with the consideration that discovery can be a solution in realizing learner-centered learning and is in line with learning with an independent curriculum because it is able to show the involvement and active role of students in the learning process.

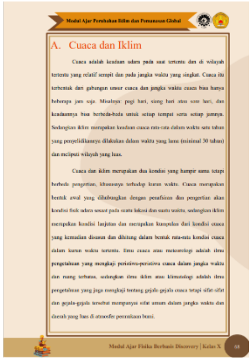
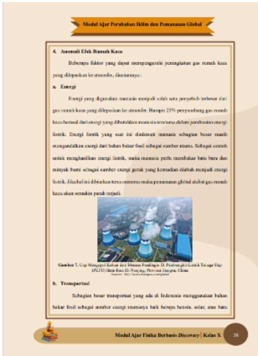
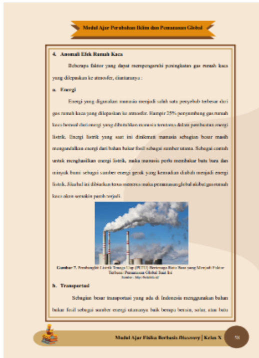
Table 6. Design Stage Results

Stages	Analysis Result
Media selection	Media selection is used to identify learning media related to the independent curriculum. The selected media is the discovery-based Physics teaching module print media.
Format selection	The formats used are: 1) the introduction section consists of the teaching module cover, preface, table of contents, and flow of learning objectives, 2) general information section, 3) core components, 4) attachment components.
Initial design	The initial design is a framework or prototype I which is designed to aim as an initial product that will be used to conduct validation. The things that need to be prepared to make prototype I are collecting general information from the Physics teaching module, reviewing the flow of learning objectives and materials that have been determined, collecting sources of material that will be contained in the teaching module, such as from independent curriculum textbooks and other reference sources, determining assessment assessments and images that will be used in teaching materials, such as from google pictures and canva. The results of the data conclusion are then made into a complete teaching module using the Microsoft word 2021 application.

The initial draft of the validated design stage received revisions from the validators described in Table 7.

Table 7. Validator Revision Result

No.	Revision	Before Revision	After Revision
1.	Changes to the cover design		

No.	Revision	Before Revision	After Revision
2.	Linking discovery indicators in reading materials		
3.	Replacing blurred images and image layout		

c. Develop

The development stage aims to produce a discovery-based Physics teaching module that has been validated and ready to be tested on students. The following are the steps taken at the develop stage.

1) Expert Appraisal

Expert appraisal aims to determine whether the Physics teaching module is valid or not. The first aspect in determining the quality of discovery-based Physics learning modules is content validity. Validity comes from the word validity which means the extent to which the accuracy of a product is able to perform its measuring function (Azwar, 2019). Validation is an activity process to assess whether the teaching module design is suitable for use or needs to be revised. This validation is also said to be rational validation because it is an assessment based on rational thinking and the absence of field facts.

Measurement of the content validity of the teaching module is carried out by presenting three experts/validators to assess the discovery-based Physics teaching module using a previously validated teaching module validation questionnaire. In the validation questionnaire, there are statement items that will be assessed and scored by the validator. During the validation process, the validator will also provide suggestions and criticism of the teaching module so that this validation process will take place repeatedly. The results of the validator's assessment were then analyzed using Aiken's V validity analysis until the validity results obtained in accordance with the validity criteria were $V \geq 0,4$.

The aspects of the validation assessment are in accordance with the assessment by BNSP, including the feasibility of content, presentation, language, and graphics which are modified and adjusted to the development of teaching modules and instruments carried out. (1) Aspects of content feasibility, validators assess the suitability of the material with learning outcomes and learning objectives, the currency of the material, and whether the content of the material can encourage readers' curiosity. (2) Aspects of presentation feasibility, validators assess presentation techniques, learning presentation, and completeness of presentation in the teaching module. (3) Aspects of language feasibility, validators assess the suitability of language with learner development and the feasibility of teaching module language. (4) Aspects of grammatical feasibility, validators assess teaching modules based on visualization, such as size, cover design, and teaching module content.

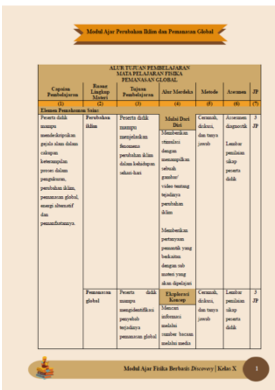
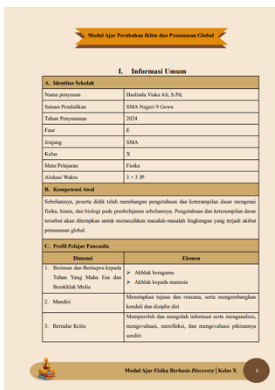
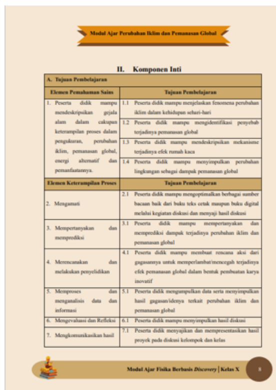
The four aspects of validation assessment contained in the validation questionnaire in total amounted to 36 statement items in the form of Likert scale ratings. The results of the Aiken's V content validity coefficient analysis are presented in Table 8.

Table 8. Content Validity Analysis of Discovery-Based Physics Teaching Module

Aspect	Total Validity Item Score	V	Criteria
Contents	6,33	0,70	Valid
Presentation	6,56	0,72	Valid
Language	6,11	0,68	Valid
Graphics	6,56	0,73	Valid

The results of the content validity analysis using Aiken's V index criteria ($V \geq 0,4$ = valid), based on four aspects of the validity assessment of the discovery learning-based Physics learning module state that overall aspects meet the valid criteria with an average value of 0.71 so that it can be stated that the discovery learning-based Physics learning module is valid and feasible to proceed to the field trial stage.

The validation results obtained are in line with research conducted by Lestari & Virman (2018) who developed a discovery learning-based Physics learning module on vector material, obtaining the average percentage of validation results from media validators of 81.96% categorized as very feasible and the average percentage of validation results from material validators of 95.62% categorized as very feasible. So based on the validation results, it is concluded that the learning module developed is valid for use in the Physics learning process in class. Results of Discovery-Based Physics Teaching Module Development:

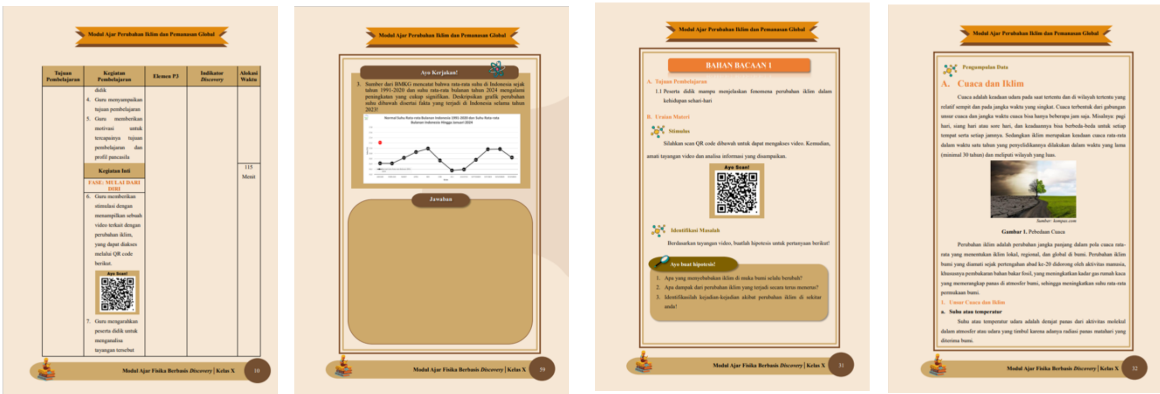


Figure 2. Discovery-Based Physics Teaching Module Used in the Test Phase

2) Developmental Testing

After the Physics learning module was declared feasible, it was tested in Class X.2 IPA at SMAN 9 Gowa. The trial of the discovery-based Physics teaching module was conducted with the test subjects over five Physics lessons covering the topics of climate change and global warming. Prior to the trial, students were given a pretest consisting of 25 items designed to assess critical thinking skills.

The critical thinking skills test included 9 questions related to interpretation, and 8 questions each for analysis and inference indicators. The test lasted approximately 60 minutes and was taken by 34 students from Class X.2 IPA at SMAN 9 Gowa.

After using the discovery-based Physics teaching module over five learning sessions, students were given a posttest to evaluate the impact of the module on their critical thinking skills. The pretest and posttest used the same questions, but the numbering was randomized in the posttest.

The results of the pretest and posttest are presented in Table 9.

Table 9. Percentage of Pretest and Posttest Scores

Criteria Interval	Category	Frequency		Percentage (%)	
		Pretest	*Posttest*	*Pretest*	*Posttest*
20 < X ≤ 25	Very good	0	7	0	20
15 < X ≤ 20	Good	3	23	9	68
10 < X ≤ 15	Medium	7	2	20	6
5 < X ≤ 10	Less	21	2	62	6
X ≤ 5	Very Less	3	0	9	0
Total		34	34	100	100

Pretest and posttest were used to see how much the students' critical thinking skills improved which was analyzed using N-Gain analysis presented in Table 10.

Table 10. Percentage of N-Gain Score of Critical Thinking Skills of Students of Class X.2 IPA

N-Gain Value	Criteria	Frequency	Percentage (%)
0,70 < *g* ≤ 100	High	5	15
0,30 < *g* < 0,70	Medium	25	73
0,00 < *g* < 0,30	Low	1	3
g = 0,00	No increase	1	3
-1,00 ≤ *g* < 0,00	Decrease	2	6

The pretest and posttest results are illustrated in Figure 3.

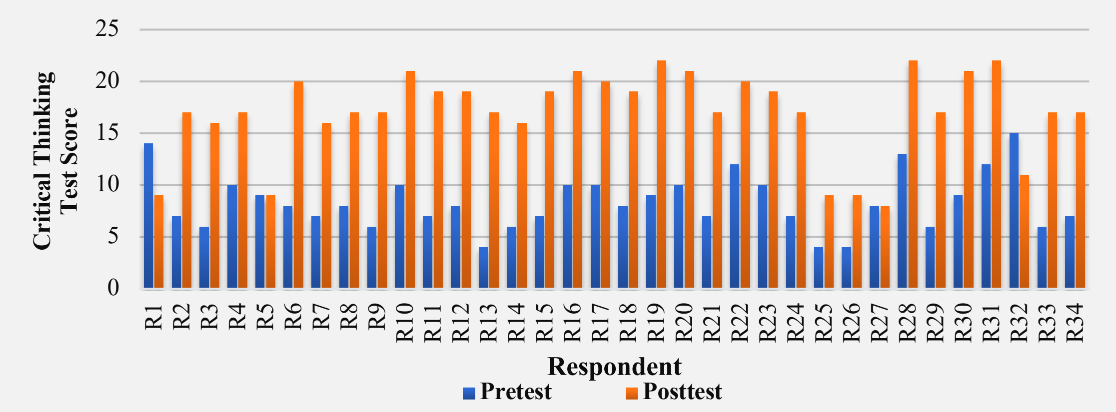


Figure 3. Pretest and Posttest of Critical Thinking Skills of Students of Class X.2 IPA

Analysis of the increase in students' critical thinking ability tests showed that there were 31 out of 34 students who experienced an increase in test results including, students who reached the high category were 5 people with a percentage of 15%, students who reached the medium category were 25 people with a percentage of 73%, students who reached the low category were 1 person with a percentage of 3% and there was 1 student who did not experience an increase in test results, and there were 2 students who experienced a decrease in test results with a percentage of 6%. Thus, based on the n-gain analysis of students' critical thinking skills as a whole, the average score is 0.56 or with a percentage of 56%, which means it is in the effective category.

Based on Table 10, it shows that there is one student who did not experience an increase in test results and there are two students who experienced a decrease in test results.

According to Asniar et al. (2022), that there are several factors that affect critical thinking skills are physical condition, motivation, anxiety, intellectual development, and interaction between educators and students. Based on interviews with Class X.2 Physics teachers regarding students who did not experience an increase in test results, it was found that these students lacked motivation and enthusiasm during Physics learning. It is also evidenced in direct observation during learning, students who do not experience an increase and decrease in test results tend not to pay attention to the learning process and do not really follow the learning process with the assignments given. Several times the learning was divided into group discussions, so sometimes in doing the assignments there were some students who were not serious, just chatting, and waiting for answers from their groupmates. Another factor is the lack of motivation, because students consider that the learning is not like usual and not from the usual teacher, and consider the learning process is only limited to research not for student learning needs. So, when students work on the questions given, they tend to just answer the questions as evidenced by the relatively fast duration of working on the questions.

According to Sihotang (2019) critical thinking skills will be difficult to develop if there is no conscious effort from students to develop them during learning. Because critical thinking will not necessarily increase in a short time, but requires repeated practice and habituation. So for future researchers, it is hoped that they can choose Physics material that is in accordance with the student's environment and integrate it in discovery learning so that students can get used to the Physics learning process that trains critical thinking skills (Kurniawan et al., 2022; Kusumaningtyas et al., 2024).

Based on suggestions and references relevant to this research and seen from the categorization of effectiveness used, the teaching module is said to be effective if the overall n-gain average results obtain a percentage of 56% (Sukarelawan et al., 2024). And the development results have a predominantly positive impact. Thus, the discovery learning-based Physics teaching module is concluded to be effective for improving students' critical thinking skills.

d. Disseminate

The dissemination was limited to practitioners, namely 12 high school physics teachers. Among them are 2 Physics teachers from SMAN 9 Gowa and 10 Physics teachers from several SMA/MA schools in Gowa Regency and Makassar City. The dissemination was carried out to obtain practitioner responses using a practitioner assessment sheet instrument that had been declared valid before. Practitioners' responses aimed to assess the level of practicality in terms of usability and ease of use by students and teachers, as well as the benefits obtained in carrying out learning using discovery-based Physics teaching modules.

Data collection was done by directly visiting the Physics teacher of SMAN 9 Gowa as many as 2 teachers and through google form to 10 other SMA/MA Physics teachers in Gowa Regency and Makassar City.

The results obtained are presented in Table 11.

Tabel 11. Results of Practitioner Assessment of Discovery-Based Physics Teaching Modules

Aspect	Average Score	Percentage (%)	Criteria
Contents	3,59	90	Very practical
Presentation	3,54	89	Very practical
Language	3,67	92	Very practical
Graphics	3,62	91	Very practical
Average	**3,61**	**90**	**Very practical**

Based on the results of the analysis of the practitioner assessment questionnaire, it was found that the discovery learning-based Physics teaching module developed met the practical criteria with a percentage of the average analysis results of practitioners of 90%, which means that the practitioner's response is in a very good and positive category towards the discovery learning-based Physics teaching module so that it is practically used in Physics learning in the classroom.

However, from the assessment, practitioners also provided suggestions and corrections to the discovery-based Physics teaching module. The suggestions and corrections given by the practitioners are: (1) the aspect of content feasibility, the suitability of the material in the teaching module to the learning objectives and learning outcomes is considered necessary to be improved, as well as adding data and facts based on the latest research results. (2) Aspects of presentation feasibility, especially the glossary section is considered to still not cover the entire content of the material in the teaching module. (3) Aspects of language feasibility, there are still parts of the writing that are wrong and not neat so they need to be corrected carefully, and (4) aspects of feasibility of graphics, the teaching module is considered to display too many components so it is necessary to simplify the parts in the teaching module.

The results of the practicality of the development of discovery-based Physics teaching modules are in line with research conducted by Ramadhan et al (2023) who developed a discovery learning-based learning module on optical instrument material obtained a percentage of 89% with a level of practicality in the very practical category used in Physics learning in SMA / MA. According to Nieveen in Haviz (2016), the developed product meets practicality in terms of ease of material and use by teachers and students in learning. Similar research was conducted by Ayu & Ahmad (2021), who developed a discovery learning-based Physics e-book on three aspects of practicality assessed resulting in an average percentage above 60% with a very practical category, so that the Physics e-book developed is suitable for use in Physics learning. As well as according to Sukmarani & Wawan (2021) in the research conducted, namely developing a discovery learning-based module which was declared feasible to use in learning Physics based on the assessment of experts.

The results of the practicality analysis obtained and previous research show that the discovery-based Physics teaching module developed is declared practical for use in learning Physics by students and teachers, especially in developing critical thinking skills. Thus, the discovery-based Physics teaching module produced can be a Physics teaching material in the independent curriculum on climate change and global warming material and can be used as a reference for teachers or other researchers in developing Physics teaching modules on other sub-materials or other 21st century skills.

4. Conclusion

The content validity of the discovery-based Physics teaching module that has been developed obtained the results of the validity coefficient test by Aiken's on four aspects of assessment, content, presentation, language, and graphics. Overall, the average score was 0.,71 with a percentage of 77%. Based on the content validity criteria used ($V \geq 0,4$ = valid), it can be stated that the discovery-based Physics teaching module developed is valid and feasible to use in improving students' critical thinking skills in Class X.2 IPA SMAN 9 Gowa.

The results of practitioners' responses obtained using the practitioner assessment questionnaire on four aspects of the assessment obtained results, in the aspect of content feasibility the teachers responded with an average score of 3.59 with a percentage of 90%, in the aspect of feasibility of presentation the teachers responded with an average score of 3.54 with a percentage of 89%, in the aspect of feasibility of language the teachers responded with an average score of 3.67 with a percentage of 92%, and in the aspect of feasibility of graphics the teachers responded with an average score of 3.62 with a percentage of 91%. Thus, overall the average practitioner assessment obtained a score of 3.61 with an average percentage of 90% and was in the very practical category, which means that practitioners gave very good and positive responses to the discovery-based Physics teaching module so that it is practical to use in Physics learning in class.

In addition, the results of the effectiveness of the development of discovery-based Physics teaching modules as seen from the test results of improving students' critical thinking skills through n-gain analysis obtained an average percentage of 56%, which means that the discovery-based Physics teaching modules developed are effective and have a positive impact on improving the critical thinking skills of Class X.2 IPA SMAN

9 Gowa students, especially on indicators of interpretation, analysis and inference.

So it can be concluded that the discovery-based Physics teaching module produced meets the criteria of valid, practical, and effective and has a positive impact on improving students' critical thinking skills as indicated by the positive responses given by the research subjects and the results of the analysis with the criteria used obtained results that are in the excellent range.

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