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Development of Project-Based Physics Teaching Modules to Improve Students' Science Process Skills

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Abstract: This study is a type of research and development (R&D). The research was conducted by the Four-D models. This study consisted of four stages, namely needs analysis (analyze), product design (design), product development (development), and product dissemination (dissemination). The purpose of this research was to produce a project-based physics teaching module to improve students' science process skills that meet the criteria of validity, practicality, and effectiveness. The project-based physics teaching module was validated by three experts. The test subjects were Grade XI students of State Senior High School 13 Takalar in the 2025/2026 academic year. The results of the study indicate that expert assessments of the developed physics teaching module were analyzed using the Aiken's V index, with an average content feasibility score of 0.78, a presentation feasibility score of 0.76, and a graphic feasibility score of 0.78 in the moderate category. Meanwhile, the language feasibility score was 0.82 in the high category. The results of the expert judgment of the project-based teaching module yielded a cumulative response score of 87.33%, categorized as very practical. The implementation observation results yielded a cumulative score of 81.30%, categorized as practical. Therefore, the project-based physics teaching module was considered feasible for implementation and use. The effectiveness of the project-based physics teaching module was determined based on the pre-test and post-test results of students' science process skills, which were analyzed using the N-gain test. Overall, the average N-gain score of students was 0.68, categorized as moderate. It can be concluded that there was an improvement in the science process skills of Grade XI students of State Senior High School 13 Takalar through the use of the project-based physics teaching module. This indicates that the project-based physics teaching module is effective for physics learning.

Keywords: Project-based learning; Science process skills; Teaching modules

Introduction

Knowledge and information have undergone significant developments in this century. This level of development encompasses various fields, including education (Meyer & Norman, 2020). Education is a crucial factor in preparing the human resources needed to face the demands of the times and technological developments. 21st-century competencies require students to be directly involved in the learning process.

In physics learning, learning is centered on actively engaged students, and it is ideally engaging, enjoyable, and meaningful for all students. In this case, teachers can process and evaluate learning appropriately without any manipulation because students receive treatment tailored to their needs. Furthermore, ideal physics learning is aligned with current developments by developing 21st-century skills such as student communication and collaboration, in line with the new paradigm. One curriculum designed to meet the needs of today's increasingly advanced era is the Merdeka Curriculum. The Merdeka Curriculum is a program created by the Ministry of Education and Culture (Kemendikbud) as a driving school program. The

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learning activities implemented in the Merdeka Curriculum are expected to create a motivating, creative, and innovative learning environment.

The new paradigm in the independent learning curriculum aims to explore students' competencies by focusing on their interests and talents, while also considering the global diversity present in their environment, so that they can have meaningful learning experiences, engage in lifelong learning, and develop strong character alongside their competencies (Nurasiah et al., 2022). However, resource constraints and teacher administrative burdens are real obstacles (Yusa et al., 2020). The independent curriculum provides teachers with the flexibility to choose, create, and develop practical learning tools.

Nurhayati et al. (2024) state that teaching modules in the independent curriculum provide flexible effects for teachers and students. Teachers are given the freedom to choose, create, use, and develop the format of teaching modules. Teachers are given the freedom to be creative and innovative in creating or developing teaching modules.

Differentiated learning is implemented in the classroom through learning tools designed by teachers to support the flow of learning activities, namely teaching modules (Cahya & Wahyuni, 2023). One of the differentiated teaching modules is project-based, which is one of the differentiated learning strategies that involves students in learning knowledge and skills through a long, structured, and complex search process and carefully designed product assignments. One of the skills in question is science process skills.

Aldi et al. (2023) state that science process skills are all skills in discovering concepts, theories, and principles that have the goal of developing each concept or refuting previous findings. Students can use scientific information to conduct scientific investigations to solve problems (Aka et al., 2010) and help them face various challenges that arise along with the development of science (Ekici & Erdem, 2020).

In the research of Rapi et al. (2025) it is explained that science process skills involve the development of cognitive, affective, and psychomotor skills. Kusmawati et al. (2025) explain that science process skills are very important in understanding scientific concepts and applying them in everyday life. In addition, they also allow students to think critically, analyze data, and solve problems scientifically.

According to Nurdiansah et al. (2021) current learning practices still encounter obstacles in developing science process skills, particularly in physics. Based on direct observation at State Senior High School 13 Takalar, the low level of students' science process skills is characterized by learning that still focuses on learning outcomes, making students' abilities in observation, interpretation, classification, prediction, and hypothesis does not develop optimally.

Direct involvement of students in understanding concepts through laboratory or virtual laboratory experiences, and designing projects, can improve students' science process skills (Nuraeni et al., 2023). According to Chistyakov et al. (2023) an effective learning approach for improving science process skills is project-based learning, especially in physics. Students can work individually or in groups during the project-based learning process.

Novianto (2023) research suggests that project-based learning immerses students in real-life projects, which require the application of these skills in a substantial context. Although promising, the practical implementation of project-based learning requires structured guidance for optimal results. Setiyadi et al. (2024) in their research results showed that by designing and developing projects that can be used to solve problems, students can demonstrate their creativity through project-based learning, which is generally referred to as a project-based learning approach.

One of the principles of project-based learning is student-centered learning that involves real-life tasks to enrich learning (Arsyad & Arafah, 2020). The teacher acts as a facilitator and evaluator who assesses the work results or achievements of students from the projects (Rahmi et al., 2020).

Ramlawati et al. (2025) suggest that project-based learning models offer a promising approach to addressing these challenges by facilitating authentic and contextual learning experiences that intrinsically motivate students to actively engage in scientific projects. Project-based learning provides a collaborative learning environment that can enhance students' collaboration and communication skills (Owens & Hite, 2022). This is in line with the research by Safaruddin et al. (2020) who found that science process skills become stronger if students are encouraged to learn and work on projects.

Puspita, (2019) suggests that by developing skills such as those acquired through a process, students will be able to discover and develop their own facts and concepts, as well as cultivate and develop the required attitudes and values. Actively involving students in completing relevant projects encourages them to improve their science process skills.

The use of teaching modules at State Senior High School 13 Takalar remains conventional, employing traditional learning methods that focus on linearly structured material. Consequently, the teaching modules lack flexibility in adapting to students' diverse learning styles. Therefore, project-based learning in experiments is more effective and produces better learning outcomes than traditional teaching (Maros et

al., 2023). This is based on the belief that project-based learning can increase student engagement and skills in the learning process.

This project-based physics learning module was designed and developed to provide students with opportunities to actively and independently learn to solve physics problems through projects relevant to everyday life. The project-based physics learning module is designed to effectively help improve students' science process skills in in-depth physics learning.

Method

Type of Research

This research uses the research and development (R&D) type. Research and Development (R&D) is a type of research that aims to produce a product through a development process. This type of research is an important approach to creating relevant and effective learning innovations (Afriani, 2025). It uses the Four D model with four stages: analysis of development needs (Analyze), product design (Design), product development (Development), and product distribution (Dissemination).

This study used a One Group Pretest and Posttest Design. The design used a pretest to determine students' basic abilities and a posttest to determine students' final abilities (Johnson & Christensen, 2014).

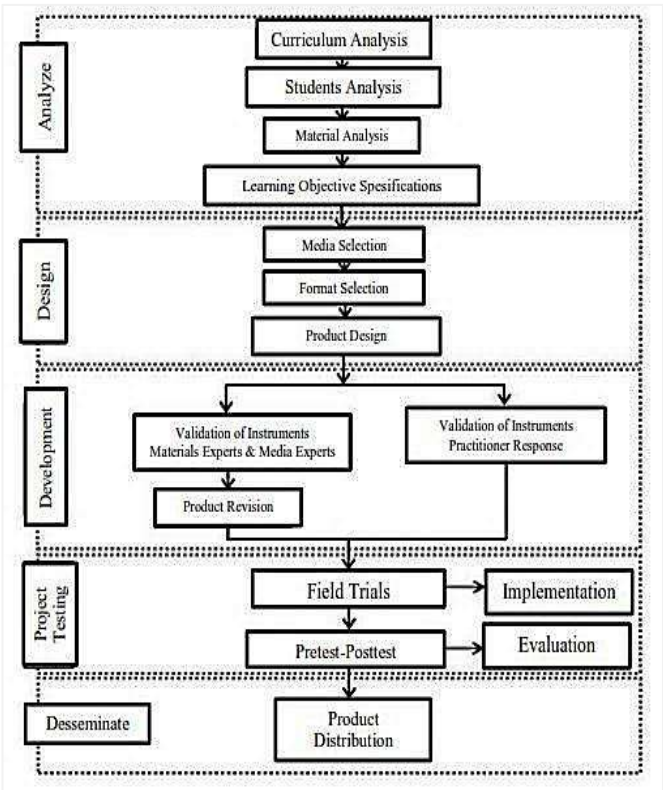

Figure 1. Research development flow

Analysis Stage

In the initial stage of the research, there are 4 steps, namely reviewing the applicable curriculum used to determine the competencies of the teaching module to be developed, analyzing the needs of students in the learning process, analyzing the material by identifying the material that needs to be taught, and sequencing of learning objectives and competencies for the limitations of the material that will be included in the teaching module.

Curriculum analysis is conducted to identify the values, skills, and profiles to be achieved in accordance with the curriculum. The curriculum used at State Senior High School 13 Takalar is the Independent Curriculum. Based on the curriculum in effect at State Senior High School 13 Takalar, students are required to be active, creative, and skilled in solving real-world problems. However, the teaching modules used tend to focus on theoretical explanations and conventional practice exercises. Learning media are one-way and only support verbal delivery of material without integrating independent exploration or project activities by students.

The analysis phase continued with student needs. Based on direct classroom observations in physics learning, it was found that students were quite active in discussions but had difficulty connecting concepts to real phenomena. The teaching modules used were mostly adaptations of the sequence of learning objectives and textbooks, and the lack of active participation in simple practicums with laboratory equipment to improve science process skills made students less focused on direct measurement activities. Therefore, the use of teaching modules with a project-based learning approach can be used so that students can connect material concepts with real applications and their implementation.

Based on the results of the student survey regarding the learning process, data were obtained on learning styles, learning media, learning methods, and forms of assignments required by students.

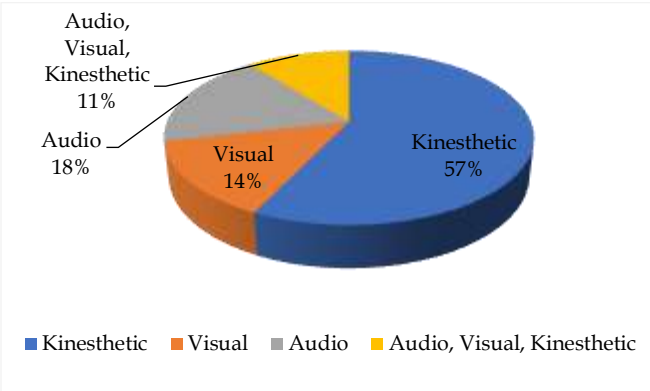

Figure 2. Student learning styles

The results of the analysis of the learning styles of grade XI students at State Senior High School 13 Takalar are 57% kinesthetic, 18% auditory, and 14% visual. The dominant learning style is kinesthetic, which involves direct practice in physical activities. With a tendency for students to understand the material more easily through direct practice, this shows that most students prefer learning that involves them directly in experiments rather than just listening to teacher explanations or reading material in textbooks. Most students also chose visual and dynamic learning media through learning videos. Students prefer to work on projects in groups and have group discussions, and produce creative work/skills with real products such as simple tools and creative presentations on understanding the material.

The analysis stage of the learning materials aims to serve as a reference material in the development of project-based physics teaching modules. The results of the material analysis to be used are heat and thermodynamics materials for grade XI physics in senior high school, odd semester. The material concepts and the teaching modules used by teachers can be integrated and directly related to real phenomena so that students can more realistically understand the physics concepts they learn through project activities. The material analysis is based on the learning outcomes listed in the Independent Curriculum.

The next stage is learning objective analysis, based on the learning outcomes and the sequence of learning objectives. The formulated learning objectives serve as a reference for designing and developing project-based physics learning modules based on the selected material.

Design Stage

The design stage is a follow-up to the analysis stage, the activities carried out are adapted from Afdalia (2020) research. The design stage includes planning the material to be developed, compiling specifications for learning objectives, determining the module framework, preparing reference sources, selecting images, and compiling the module.

The first stage is media selection. This stage involves determining the appropriate type of media to support project-based learning activities in the research. The purpose of selecting learning media is to select the media to be used in the research. Media selection is based on the learning outcomes in the independent curriculum used. The learning media used is a project-based physics teaching module that teachers can use in the learning process. The media selection aims to facilitate students' understanding of physics material by considering student needs, learning objectives, and the availability of facilities and infrastructure at the school.

After developing the media, the design phase continues with selecting a format based on the Independent Curriculum used at State Senior High School 13 Takalar. The physics teaching module format was systematically structured, including a table of contents, general information, learning outcomes, sequence of learning objectives, learning objectives, project-based learning activities, assessments, and appendices. The format was created with a consistent appearance, attractive color combinations, a structured and systematic material structure, and a communicative and informative font, and language.

After completing both design stages, the next step is designing a project-based physics learning module. The physics learning module design at this stage includes the development of a learning flow and the design of project-based learning module components. The learning module is designed to include project-based learning steps, from problem definition and project planning to implementation, monitoring, and product evaluation. Each activity is provided with clear instructions and an assessment rubric to facilitate students in developing project products that meet learning objectives.

Development Stage

The development stage of the teaching module is based on components previously designed during the design stage. The materials are created and structured according to the plan created during the design stage. The goal of this development stage is to produce a project-based teaching module and research instruments. This research involved two stages: the initial product design and the feasibility test of the project-based physics teaching module, which was validated by experts.

The project-based physics teaching module design was validated by validators consisting of expert lecturers and subject teachers who met the specified criteria. The developed physics teaching module was then validated, or tested, for its appropriateness in terms of content, presentation, language, and graphics. The instrument used to assess the appropriateness of the physics teaching module by the experts was a validation sheet.

The next stage, revision, was carried out based on the results of the feasibility test of the teaching module by experts. After validation and revisions, as well as improvements made by material experts and media experts, a product trial was conducted. The product trial was conducted on XI grade students at State Senior High School 13 Takalar. Then, an observer was given an implementation observation sheet to assess the practicality of the project-based physics teaching module used. Next, an evaluation was conducted with students after providing the material with the developed teaching module to test its effectiveness.

Disseminate Stage

The disseminate stage aimed to disseminate the developed and validated teaching modules, introduce them, and support their use among physics teachers in several schools in Takalar Regency. Respondents provided feedback on the developed teaching modules using a practitioner response questionnaire.

This study employed a one-group pretest-posttest design. There were two forms of evaluation: an initial evaluation (pretest) conducted at the beginning of the lesson and a summative evaluation (posttest) to measure the effectiveness of the learning process and obtain feedback.

Data Collection Technique

Questionnaire

According to Sugiyono (2017), a questionnaire is a data collection technique carried out by providing a set of written questions or statements to respondents to answer. The questionnaire is used to obtain product validity data from validators and to determine practitioners' responses to the developed teaching module. The questionnaire will be given to experts in the form of a validation questionnaire by material experts and a validation questionnaire by media experts, which are used to assess the feasibility of the developed project-based physics teaching modules. Then, the validation questionnaire will also be given to practitioners in the form of an assessment questionnaire for the developed project-based physics teaching modules, and will be assessed by several physics teachers.

Implementation Observation Sheet

The implementation observation sheet is used to measure how well teachers implement project-based physics teaching modules based on observations during the learning process. The observation sheet is completed by one observer, the physics teacher. Before use, the observation sheet was validated by an expert. The implementation observation sheet proved highly valid, with the decision being that it could be implemented with minor revisions.

Test

A test is an instrument or methodology used for quantification and evaluation purposes (Resti, 2023). The test used consisted of questions on science process skills. The test in this study was used to determine the extent to which students at State Senior High School 13 Takalar had improved their science process skills using a project-based physics teaching modules.

The test used in this study was a pretest and posttest consisting of multiple-choice questions. The pretest was administered before students began learning with the project-based physics teaching module, while the posttest was administered after the learning activities using the project-based physics teaching modules were completed.

A number of previous studies have developed various science process skills assessment instruments, such as performance-based tests, observation sheets, and project-based assessments (Kleinschmit et al., 2024). The instruments used in the research were validation sheets, practitioner response questionnaires, and science process skills tests.

Data Analysis

Feasibility Validation Questionnaire Analysis of the Teaching Modules

Validation data for the suitability of the teaching module was obtained from material and media validation questionnaires conducted by material and media experts. The researchers provided a checklist of categories based on a 1 to 4 rating scale for the assessment criteria: Very Poor, Less Good, Good, and Very Good.

Validity testing was conducted to measure and identify what should be measurable. The analysis used was Aiken's V. Aiken's V index analysis is an index of agreement among validator experts regarding the suitability of an item to the indicator it is intended to measure. The Aiken's V equation is as follows.

$$V = \frac{\sum S}{[n(c-1)]} \quad (1)$$

$$S = r - l\,o \quad (2)$$

Description:

V : Aiken validation index

c : highest validation score

n : number of assessors

r : score given by assessors

l_o : lowest validation score (Hidayah, 2023)

Table 1. Aiken Validity Test Result Categories

Validity Index	Interpretation Criteria
0 ≤ V ≤ 0.40	Low
0.40 < V ≤ 0.80	Medium
0.80 < V ≤ 1	High

Practicality Questionnaire Analysis of Teaching Modules

The practicality of the project-based physics teaching modules was assessed using observation sheets on the implementation of learning and questionnaires on practitioners' responses to the developed physics teaching module. The data obtained were then analyzed using the following formula (Sugiyono, 2019).

$$PRS = \frac{\sum X}{N}\ x\ 100\% \quad (3)$$

Description:
PRS : percentage of data
$\sum x$: total score obtained
N : maximum score

Table 2. Practicality Categories of Teaching Modules (Novi et al., 2024)

Assesment	Category
81% – 100%	Very Practical
61% – 80%	Practical
41% – 60%	Fairly Practical
21% – 40%	Not Practical
≤ 20%	Very Impractical

Questionnaire Effectiveness Analysis of Teaching Modules

The effectiveness of the physics learning module was assessed using a test instrument that assessed students' science process skills using the developed learning modules. Science process skills were measured using pretest and posttest results to determine student improvement after using the project-based physics learning module as learning material. Data analysis used the N-gain, or normalized gain, test formula with the following steps:

1) Calculate using the N-gain test formula using the following equation:

$$g = \frac{Xm - Xn}{\max score - Xn} \quad (4)$$

Description:
g : gain normality
X_m : posttest score
X_n : pretest score

2) Then determine the average value of the N-gain score.
3) Determine the N-gain test result criteria. The N-gain test result criteria are shown in Table 3 and Table 4.

Table 3. N-Gain Values (Nabil et al., 2021)

Value	Description
0.70 ≤ n ≤ 1.00	High
0.30 ≤ n ≤ 0.70	Medium
0.00 ≤ n ≤ 0.30	Low

Table 4. N-Gain Effectiveness Interpretation Categories (Hake & Reece, 1999)

Value	Description
< 40	Ineffective
40 – 55	Less effective
56 – 75	Quite effective
> 76	Effective

Results and Discussion

The research conducted aims to analyze the content validation, practicality, and effectiveness of the project-based physics teaching module developed in improving students' science process skills and to produce a project-based physics teaching module that meets the criteria of being valid, practical, and effective.

This research is a type of research and development (R&D). The product developed is a project-based physics teaching module to improve students' science process skills. The developed physics teaching module is used by educators for use in learning. Based on the objectives to be achieved in this study, the researcher took a trial class at State Senior High School 13 Takalar, namely class XI, totaling 30 students.

This physics teaching module consists of several sections. On the front there is a cover designed with images, colors, and fonts that match the characteristics of the presented physics material. The table of contents section, which is the structure of the teaching module, makes it easier for educators to find the sections needed during its use. The general information section is used by educators to understand the scope of the material and activities, as well as learning objectives. It contains learning outcomes, the flow of learning objectives, and learning objectives to be achieved in each learning activity. The activity section contains the syntax of project-based learning and the syntax of science process skills. Then the assessment and attachment sections, which consist of supporting materials and worksheets, provide an overview of the development of student abilities, especially in the material of heat and thermodynamics. This project-based physics teaching module was also developed with the help of Canva and Microsoft Word applications, which differentiates it from the module used by the XI grade physics teacher at State Senior High School 13 Takalar.

In the development stage of the project-based physics teaching module, the initial analysis carried out was the development needs analysis. Researchers analyzed the needs by reviewing the curriculum at State Senior High School 13 Takalar, which is in effect, namely the Independent Curriculum, used to determine the competencies of the developed teaching module. By analyzing the needs of students in the learning process, it was found that students were quite active in discussions but had difficulty in linking concepts to real phenomena. By analyzing the material and identifying students' learning styles from the results of observations obtained, the dominant kinesthetic learning style was owned by a percentage of 50%, and understanding of the material was 46.9% through direct physical practice. Then the objectives and competencies of learning were analyzed based on learning outcomes, which are described in a sequence of learning objectives.

After conducting a needs analysis, the next stage is product design by adjusting the format and designing the content of the project-based physics teaching

module. The teaching module is equipped with a project-based learning syntax, namely basic questions, designing a project plan, preparing an implementation schedule, monitoring the activity and progress of the project, testing the results, and evaluating the learning experience. The project-based teaching module is created in accordance with the physics learning materials for grade XI of the Independent Curriculum. The materials applied in the project-based physics teaching module are heat and thermodynamics.

Furthermore, in the product development stage, validation of the project-based physics teaching module was carried out. The developed teaching module was assessed by three experts to measure the content validity, practicality, and effectiveness of this project-based physics teaching module. The assessment of the teaching module components provided by the validator included an assessment of the content feasibility aspect, an assessment of the presentation feasibility aspect, an assessment of the language feasibility aspect, and an assessment of the graphic feasibility aspect (Badan Standar, Kurikulum, & Asesmen Pendidikan, 2022).

Development of Project Based Physics Teaching Modules to Improve Science Students' Process Skills

Content Validity Results of Project-Based Physics Teaching Modules

Based on the results of content validity by three experts, the data were analyzed using the Aiken's V index test by looking at the content validity coefficient of the validated instrument. The teaching module instrument is said to be valid if the content validity coefficient is greater than 0.4.

Table 5. Average Assessment of Aspects of Project-Based Physics Teaching Modules with Aiken's V Index

Assesment Aspects	∑S	n(c-1)	V	Description
Content	211	270	0.78	Valid
Presentation	103	135	0.76	Valid
Language	66	81	0.82	Valid
Graphics	196	252	0.78	Valid
Average			0.78	Valid

Based on the data in Table 5, the average assessment of the three validators shows that the validity results of the project-based teaching module indicate a high level of feasibility in all aspects. In the content feasibility aspect, an average validity index of 0.78 was obtained in the moderate category. In the presentation feasibility aspect, an average validity index of 0.76 in the moderate category was obtained. In the language aspect, an average validity index of 0.82 was obtained in the high category. Meanwhile, in the graphic aspect, an average validity index of 0.78 was obtained in the moderate category. The average results of the assessment by the three validators show an average content validity coefficient of 0.78, all of which fall into the moderate category. So, it can be stated that the project-based physics teaching module is valid and can be used with minor revisions. The physics teaching module is suitable for use in State Senior High School 13 Takalar as an alternative learning resource that can be used by educators.

Validation Results of the Practitioner Assessment Questionnaire Instrument

After the project-based physics teaching module was validated, a validity assessment was carried out on the practitioner assessment questionnaire sheet and the implementation observation sheet by three experts. The aspects assessed on the practitioner questionnaire sheet and the implementation observation sheet in this study were the instructions for filling out the questionnaire, content, and language. The validator validation data on the practitioner assessment questionnaire instrument were used to obtain data from practitioners (physics teachers), consisting of several statement items, which were analyzed using the Aiken's V index. The selected practitioner teachers were subject teachers with a bachelor's degree (S1) and had a Civil Servant Identity Number (NIP). The aim was to determine the level of practicality of the project-based physics teaching module developed.

Table 6. Average Assessment of the Implementation Observation Sheet Questionnaire with Aiken's V Index

Assesment Aspects	∑S	n(c-1)	V	Description
Questionnaire Completion Instructions	34	45	0.76	Valid
Content	73	90	0.81	Valid
Language	70	90	0.78	Valid
Average	59	75	0.78	Valid

Based on the data in Table 4.6, the questionnaire's instructional component obtained a validity index with an average of 0.76, categorized as valid. The content component obtained a validity index with an average of 0.81, categorized as valid. Meanwhile, the linguistic aspect obtained a validity index with an average of 0.78, categorized as valid. Therefore, it can be said that the implementation observation sheet is valid.

Validation Results of Science Process Skills Test Instruments

The developed science process skills test instrument was then validated by three experts to determine the feasibility of each test item. The test instrument was designed in the form of 30 multiple-choice pretest and posttest questions on the physics topic of heat and thermodynamics. Test instruments deemed feasible were used to measure the improvement

of students' science process skills. The validation scores of the three validators were then analyzed using the Aiken's V index.

Table 7. Content Validity Analysis of Pretest and Posttest Instruments for Science Process Skills with Aiken's V

Assesment Aspects	∑S	n(c-1)	V	Description
Classification	61	72	0.85	Valid
Interpreting	26	36	0.72	Valid
Predicting	43	54	0.80	Valid
Applying Concepts	84	108	0.78	Valid
Average	54	68	0.79	Valid

Based on Table 7, the results of the content validity of the science process skills test items in this study obtained an average (V) of 0.79 in the valid category. The results of the expert validation analysis of the science process skills test instrument were declared valid and suitable for use in research with minor revisions. After revisions and approval by experts, the instrument was considered suitable and could be used in the limited trial stage in class XI of State Senior High School 13 Takalar.

Practitioner Assessment Results of Project-Based Physics Teaching Modules

Practitioner assessment of the project-based physics teaching module was conducted in the learning process at school. The practitioner assessment questionnaire was completed by ten physics teachers at several schools in Takalar Regency, namely State Senior High School 1 Takalar, State Senior High School 3 Takalar, State Senior High School 5 Takalar, State Senior High School 8 Takalar, State Senior High School 11 Takalar, and State Senior High School 13 Takalar.

All aspects of the assessment components of the project-based physics teaching module assessed by practitioners obtained a percentage score of 89.58% in the content aspect, 87.83% in the presentation aspect, 86.11% in the language aspect, and 85.80% in the graphic aspect. Cumulatively for each aspect it obtained a percentage of 87.33% with a Very Practical category. So, the development of the project-based physics module obtained valid and practical results for use in physics learning based on practitioner assessments. This is in accordance with previous research conducted by Fatmawati et al. (2022) regarding the development of project-based learning tools that can improve students' science process skills, as seen from the results of the practitioner assessment obtained, which are in the very practical category, so that project-based learning tools are suitable for use in learning.

Meanwhile, the implementation observation sheet that has been validated and declared valid was then given to one observer, namely a grade XI physics teacher at State Senior High School 13 Takalar, to see their response to the implementation of the project-based physics teaching modules used in learning. The observer made observations at each meeting. The indicator aspects assessed in the implementation observation sheet include observation indicators, classification, interpreting, predicting, asking questions, hypothesizing, planning experiments/research, applying concepts, and communicating. All aspects of the implementation assessment indicators for the project-based physics teaching modules cumulatively obtained an average percentage score of 81.3% and were in the Very Practical category.

Effectiveness of Project-Based Physics Teaching Modules

The effectiveness of the project-based physics teaching module was measured using a science process skills test instrument given to grade XI students of State Senior High School 13 Takalar. The science process skills test was given to students before the learning process. A pretest was conducted to measure students' initial knowledge before participating in physics learning on the Heat and Thermodynamics material. After the learning process, a posttest was conducted to see the improvement in students' science process skills.

Table 8. Results of the Analysis of Students' Science Process Skills Test Scores

Parameters	Pre-test		Post-test	
	Scores	Values	Scores	Values
Maximum Ideal Score	30	100	30	100
Minimum Ideal Score	0	0	0	0
Maximum Empirical Score	15	50	27	90
Minimum Empirical Score	9	30	21	70

Based on the data in Table 8, it shows the acquisition of increased science process skills as reviewed from the data on pretest and posttest scores in 30 students. The maximum empirical score of students for the pretest score was 15 with a value of 50, and the minimum empirical score of students was 9 with a value of 30. While the maximum empirical score of students for the posttest score was 27 with a value of 90, and the minimum empirical score of students was 21 with a value of 70. The results of the validity of the content of the science process skills test items in this study obtained an average (V) of 0.79 in the valid category. The results of the expert validation analysis of the science process skills test instrument were declared valid and suitable for use in research with minor revisions.

To obtain the effectiveness of the project-based physics teaching module, the students' science process skills test was analyzed using N-Gain, which can be seen in Table 9.

Table 9. N-Gain Score of Science Process Skills of Grade XI Students of State Senior High School 13 Takalar

Parameters	Category	Number of Students	PRS (%)
g > 0.70	High	12	40%
0.30 ≤ g < 0.70	Medium	18	60%
g < 0.30	Low	0	0%
Total Score		30	100%

Based on the analysis results, the average N-Gain was 0.68, which is in the medium category. A total of 12 people, or 40% of students, were in the N-Gain parameter range > 0.7 in the High category, 18 people, or 60% of students, were in the N-Gain parameter range > 0.3 in the Medium category, and there were no students in the low category. The results of this research are in line with the results of previous research conducted by (Batrisyia et al., 2024) regarding research with a pretest-posttest design for class X students, resulting in an increase in science process skills with an N-gain of 0.61 in the medium category after implementing project-based learning.

The science process skills of class XI students at State Senior High School 13 Takalar based on the pretest and posttest scores can be seen in the form of a bar chart in Figure 3.

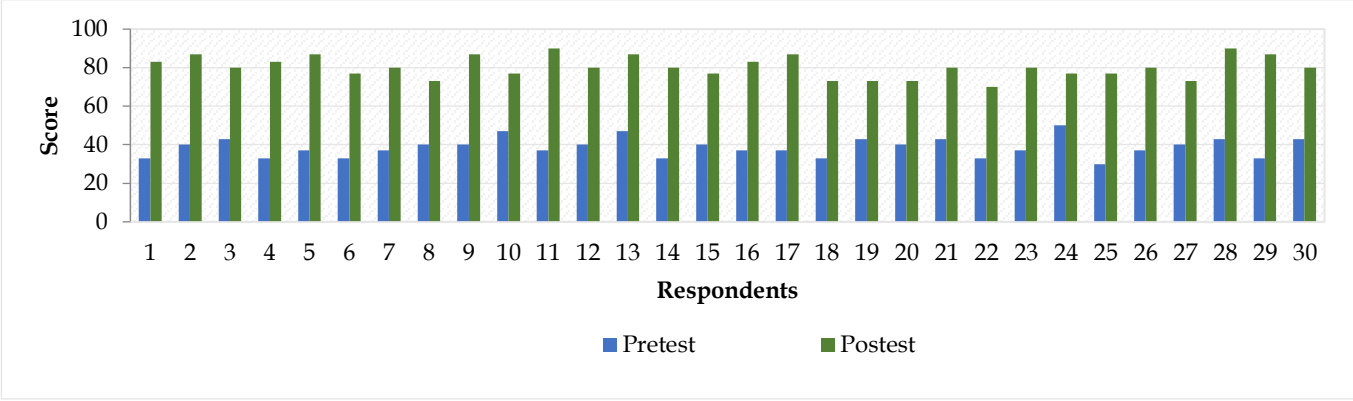

Figure 3. Pretest and posttest scores of students' science process skills

This indicates an increase in student scores, with an average score of 0.68, falling within the moderate category. Therefore, it can be interpreted that the use of project-based physics learning modules is quite effective in physics learning. An analysis was then conducted for each science process skill indicator, yielding the following results in Table 10.

Table 10. Results of Analysis of Each Student Process Skills Indicator

Indicators	Average Pretest Score	PRS (%)	Average Posttest Score	PRS (%)
Classification	3.20	40.00	6.40	80.00
Interpreting	1.40	34.20	2.30	58.30
Predicting	3.00	50.60	5.10	85.60
Applying Concepts	4.00	33.30	10.20	85.30

It was obtained that the results of the analysis of the pretest and posttest of students for each indicator were as follows. The classification indicator obtained an average pretest score of 3.2 with a percentage of 40.0% and an average posttest score of 6.4 with a percentage of 80.0%. The interpreting indicator obtained an average pretest score of 1.4 with a percentage of 34.2% and an average posttest score of 2.3 with a percentage of 58.3%. The predicted indicator obtained an average pretest score of 3.0 with a percentage of 50.6% and an average posttest score of 5.1 with a percentage of 85.6%. While the indicator of applying concepts obtained an average pretest score of 4.0 with a percentage of 33.3% and an average posttest score of 10.2 with a percentage of 85.3%.

The improvement in science process skills of grade XI students at State Senior High School 13 Takalar can be seen in Figure 4. Based on the analysis results, it shows that the use of project-based physics teaching modules provides direct learning experiences through investigation, discussion, and experimentation activities, thus encouraging students to build and develop science process skills more effectively. Thus, it can be stated that project-based physics teaching modules are quite effective in improving students' science process skills. This is also in line with previous research conducted by Hasanah et al. (2018) on physics modules based on project-based learning on temperature and heat materials that can improve students' science process skills and critical thinking

skills effectively. So, it can be concluded that the effectiveness of project-based physics teaching modules is indicated by the increase in students' science process skills through N-Gain score analysis in physics learning, especially on heat and thermodynamics materials in class XI of State Senior High School 13 Takalar.

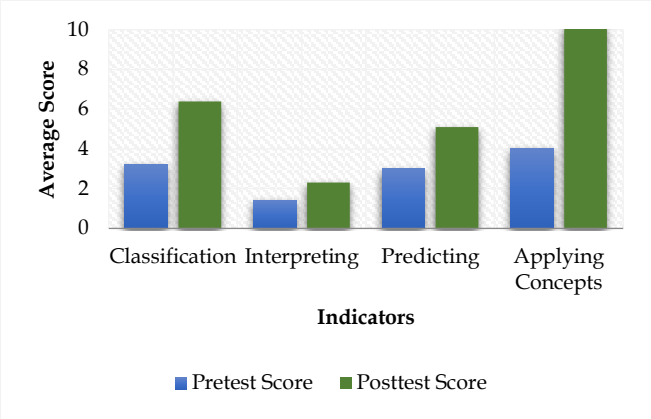

Figure 4. Improving students' science process skills

Conclusion

Based on the results of research and development of project-based physics teaching modules to improve the science process skills of class XI students of State Senior High School 13 Takalar, it can be concluded that by using the Aiken's V index test, the average content validity value was 0.78 in the medium category, the results of the practitioner questionnaire content validity obtained an average of 0.81 in the high category, and the results of the learning outcome test content validity obtained an average of 0.78 in the medium category. Overall, the validity results were declared suitable for use. The cumulative practitioner response score was in the very practical category. And the cumulative implementation observation score was in the very practical category. This shows that practitioners gave a positive response to the developed project-based physics teaching module. Meanwhile, the use of the project-based physics teaching modules carried out at State Senior High School 13 Takalar was identified using N-gain analysis, which shows that 12 students obtained an increase in science process skills in the high category and were effective to use, while 18 students obtained an increase in science process skills in the medium category and were effective to use. So, the project-based physics teaching module is effective in improving students' science process skills.

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Author Contributions

N.H.M.R: Conceptualization, methodology, writing the original draft, formal analysis, investigation, visualization, and writing—review and editing. K.A. & P.P.: Validation, supervision, and resources. All authors have read and approved the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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