JPPIPA 11(7) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

# Implementation of Problem Based Learning-Science Technology Engineering Art and Mathematics Module to Improve Students' Science Process Skills

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Received: May 23, 2025
Revised: June 26, 2025
Accepted: July 25, 2025
Published: July 31, 2025

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DOI: 10.29303/jppipa.v11i7.11879



**Abstract:** This study aims to analyze the improvement of students' science process skills after the implementation of PBL-STEAM-based science modules on simple mechines materials. This research development (R&D) uses a 4D approach from Thiagarajan, focused on the development stage. The instruments used include needs analysis questionnaires, SPS tests, expert validation sheets, and readability questionnaires. The data of this study was obtained from a validation questionnaire with an Aiken's V value filled out by media experts (0.893), material experts (0.897), linguists (0.881), and learning experts (0.887). The trial was limited to 15 students and 3 teachers showing a module readability of 90%. Field trials with pre-test and post-test resulted in an N-Gain value of 0.8, indicating a high increase in student SPS. Thus, PBL-STEAM-based science modules have proven to be feasible to improve students' science process skills.

**Keywords:** PBL-STEAM; Science process skills; Simple machines

## Introduction

More than just understanding concepts and facts, effective science learning must be able to develop students' science process skills (SPS). Through the development of this SPS, students will become more critical, creative, and capable of thinking logically, which is an important foundation for future advances in science and technology (Harta et al., 2019). And SPS is a series of essential abilities that include observation, inference, classification, measurement, prediction, communication, data interpretation, as well as hypothesis formulation and experimental execution (Gizaw & Sota, 2023). The mastery of SPS allows students to not only understand natural phenomena, but also to be actively involved in scientific investigation, problem-solving, and applying knowledge in daily life.

However, the reality on the ground shows that the SPS rate of students in Indonesia still needs serious attention. Various studies and observations often indicate that science learning tends to be teacher-centered and does not provide space for students to explore, experiment, or build their own knowledge (Faisal & Martin, 2019). This has a direct impact on the low mastery of student SPS. When students are only passive recipients of information, they struggle to develop important skills such as observing, classifying, measuring, inferring, predicting, communicating, and formulating hypotheses (Gizaw & Sota, 2023). In fact, these skills are an essential foundation for an in-depth understanding of science concepts and scientific problem-solving. Without hands-on experience in the scientific process, students tend to memorize facts without understanding the essence and application of science in everyday life (Milla et al., 2019). This condition is exacerbated by the limited facilities and infrastructure in many schools, as well as the lack of teacher training in implementing a more student-oriented approach to learning and science process skills (Permana et al., 2023). The dominant teaching method of lectures and the lack

**How to Cite:**
Aliyah, H., Saputro, S., & Sarwanto, S. (2025). Implementation of Problem Based Learning-Science Technology Engineering Art and Mathematics Module to Improve Students' Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *11*(7), 378–386. https://doi.org/10.29303/jppipa.v11i7.11879

of practicum activities or investigation projects cause students to become passive, less motivated, and have difficulty in internalizing and implementing SPS independently. This condition inhibits the formation of students' scientific character and high-level thinking skills (Harris et al., 2019).

Realizing the urgency of increasing SPS, innovation in science learning strategies is crucial. Therefore, an approach is needed that not only focuses on knowledge transfer, but also actively engages students in problem-solving activities and experiments that train every aspect of SPS in an integrated manner. One of the approaches that is considered very potential is the integration of PBL with STEAM. This approach allows students to learn actively through real-world problem-solving, develop interdisciplinary thinking, and hone creativity and innovation relevant to the challenges of the 21st century (Purwaningsih et al., 2024). PBL is a learning model that challenges students with real-world problems, encouraging them to seek solutions through investigation, collaboration, and critical thinking (Hendarwati et al., 2021). This integration between PBL and STEAM creates a dynamic learning environment, where students not only build conceptual understanding but also develop relevant 21st century skills. Meanwhile, STEAM is an interdisciplinary framework that combines science, technology, engineering, art, and mathematics, promoting creativity, innovation, and problem-solving abilities in a holistic manner (Verma, 2024). The combination of PBL and STEAM is expected to create a dynamic, relevant, and stimulating learning environment for students to actively develop their SPS.

In this context, the development and implementation of PBL-STEAM-based science modules is a promising solution. This module is designed as a systematic learning guide, integrating the stages of PBL and STEAM elements in each activity. Through this module, students will be exposed to contextual problems that require them to use a variety of scientific, technological, engineering, art, and mathematical skills to find solutions. Thus, this module is expected to facilitate students in building an in-depth understanding of science concepts while honing their SPS in a structured and sustainable manner. A number of previous studies have shown that the use of innovative learning modules that integrate constructivist and multidisciplinary approaches such as PBL and STEAM significantly improves students' understanding of science process concepts and skills. Mufidah et al. (2023) found that students who studied using similar modules showed a higher improvement in SPS scores compared to the control group. Similarly, research from Dewi et al. (2023) revealed that project-based modules and art integration can increase students' learning motivation and problem-solving skills in science learning.

This article aims to conduct a feasibility analysis of PBL-STEAM-based science modules in improving students' science process skills. The results of this analysis are expected to make a significant contribution to the development of a more innovative science curriculum, as well as a reference for educators and policymakers in designing science learning that not only focuses on mastering concepts, but also on the formation of a strong SPS as a provision for students to face future challenges.

## Method

This research is adevelopment research (R&D) that uses the 4D development model from Thiagarajan. The stages passed in this model include define, design, develop, and dissemination (Thiagarajan et al., 1976). The focus of this research is up to the development stage, while the dissemination stage will be carried out through scientific publications in journals (SINTA 2). The assessment instruments used in this study include: needs analysis questionnaire sheet, science process skills test sheet in the form of description questions, expert validation sheet, and module readability questionnaire sheet.

In the definition stage, a series of analyses are carried out to understand development needs. This analysis will identify problems, student characteristics, relevant tasks, concepts to be developed, and formulation of learning objectives. Data for this analysis will be obtained through the distribution of a needs analysis questionnaire to students related to science learning at SMP Negeri 2 Balen, Bojonegoro Regency, East Java.

At this defining stage, the researcher conducts a comprehensive needs analysis to ensure that the PBL-STEAM-based science module developed can effectively improve students' science process skills. Preliminary analysis shows that students' understanding of the concept of simple machines still needs to be significantly improved, where 100% of students have difficulty understanding and do not know how it works, and are not able to relate the concept to daily life. However, there is positive potential because the majority of students (80%) show interest in simple machines materials. This is reinforced by the fact that a small percentage of students (29%) have encountered simple machines principles-based tools in their daily experiences. However, students' independent learning process is hampered by limited access to books or teaching aids that are sufficient to learn this material at home. Survey data revealed that 96% of students prefer to learn through experimentation rather than reading and listening. Meanwhile, 94% of students prefer to study in groups rather than independently, a preference consistent with the statement of the majority of teachers (75%) that their students understand the material more easily through experiments and prefer to learn in groups. Although initial understanding of the concepts of style and effort varies (67% already know, 33% have not), and only 40% of students have practical experience with work facilitation tools, this strong interest in hands-on experiential learning and social interaction indicates great potential for effective module development. The results of the needs analysis underscore the importance of introducing a more active and integrated learning approach to PBL-STEAM. The survey findings show significant gaps, namely students are rarely exposed to daily problem-based learning, are not used to finding and analyzing information for problem solving, and lack design experience. Although the ability to evaluate designs is quite potential, the basis for implementing PBL-STEAM is still weak. Therefore, the results of this analysis are the basis for the development of PBL-STEAM-based science modules on simple machines. This module is named PBL-STEAM-based science module because its preparation refers to learning steps according to the PBL-STEAM syntax, including: Student orientation to STEAM problems; STEAM-Based Exploration and Investigation; Guided STEAM-Based Investigation; Creation, Production, and Presentation of STEAM-Based Products; and STEAM-Based Product and Process Evaluation.

The science process skills that are improved in this study are observation (observation), formulating problems, formulating hypotheses, designing models, communicating results, and drawing conclusions. The learning objectives are compiled based on the learning outcomes that have been determined, namely so that students can "take measurements of the physical aspects they encounter and utilize a variety of motions and forces, and pressures, including simple machines ", in order to guide the teaching and learning process and ensure mastery of essential concepts of science and daily life. The learning objectives are that students are able to explain the benefits of using simple machines, students are able to describe how several simple machines work in daily life, and students are able to apply simple machines that are in accordance with the problems encountered around.

In the design stage, the design of the IPA PBL-STEAM module is carried out with simple machines material, which includes the creation of a cover design and the systematic preparation of the module, so that a draft I module is formed. At this stage, the modules are arranged based on the PBL-STEAM syntax, so that the learning flow becomes systematic and integrated in one real project.

At the design stage of this research, the main focus is the design of PBL-STEAM-based science modules for simple machines materials. This stage is crucial in determining the foundation and structure of the modules to be developed. The design process begins with the design of the visual and structural elements of the module which includes the preparation of instruments, the selection of media and teaching materials, and the preparation of the initial design of the module, which then results in an initial draft. The preparation of this research instrument aims to connect the planning stages with the implementation of evaluation. The instruments developed include: validation of PBL-STEAM-based science modules, validation of science process skills tests, the effectiveness of PBL-STEAM-based science modules on simple machines materials (in the form of science process skill test questions), and PBL-STEAM-based science module readability instruments.

The design of the module cover was created with visual appeal and relevance to the content of the IPA, particularly the simple machines material. The selection of colors, illustrations, and typography aims to create a professional, attractive, and informative impression. The cover is designed to be able to provide users with an initial overview of the content and learning approach of the module, namely PBL-STEAM.

The cover of this module is predominantly light blue, which is often associated with science, technology, and education. This light blue shade creates a calm, bright, and friendly impression, perfect for learning materials for junior high school students. To attract attention, the texts "SCIENCE MODULE (PBL-STEAM)" and "PROBLEM BASED LEARNING-SCIENCE TECHNOLOGY ENGINEERING ART AND MATHEMATICS" use modern, bold, and easy-to-read Rubik One typefaces. Meanwhile, the title "SIMPLE MACHINES" is the main focus with larger, thicker, green shrikhand letters. The text "Practice Science Process Skills" is written in Bukhari Script, while "PHASE D JUNIOR HIGH SCHOOL GRADE VIII" uses League Spartan letters which are thinner and smaller in size than the title. The author's and university's information, i.e. "HIMATUL ALIYAH NIM S832308007", uses a smaller sans-serif typeface.

Module Systematics Arrangement: The module systematics are systematically arranged based on the PBL-STEAM syntax. This includes the beginning, core, and cover. The initial section consists of a title page, a francis page, an introduction, a table of contents, and a list of images. The core part of this module contains an introduction and learning activities. The introduction includes learning outcomes, indicators, and objectives, PBL-STEAM syntax, study instructions, and module content maps. Meanwhile, the learning activities contain the stages of "let's observe", "let's discuss", "let's work", "let's create", and "let's evaluate performance" which have been summarized in the module content map, as seen in Figure 2. The concluding section contains a science process skills test, a glossary, a bibliography, and an author profile. Each section is designed to facilitate active and constructive learning in accordance with PBL and STEAM principles. This systematic arrangement ensures that the modules have a logical, coherent, and supportive flow to achieve learning objectives.

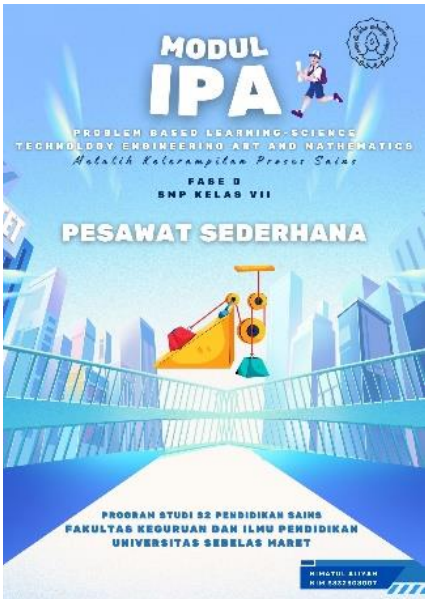



**Figure 1.** Module cover

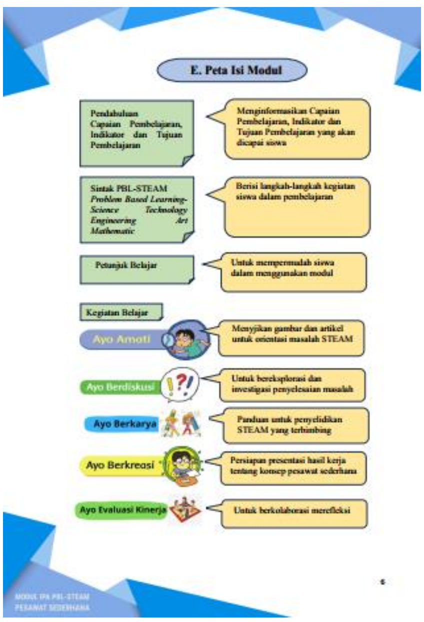



**Figure 2.** Map of the contents of the module

The result of this design stage is Draft I of a science module based on PBL-STEAM of simple machines material. The draft includes a complete outline of the module, from the cover to each section of the learning, but still requires further validation and development at a later stage. This draft I is the main reference for the development and improvement of the module in the next stages.

In the development stage, the PBL-STEAM-based science module is tested to ensure its validity, readability and practicality for students, as well as measure its effectiveness in improving students' science process skills. This development stage involves several crucial steps to ensure the quality and effectiveness of the modules. First, expert validation is carried out by linguists, material experts, media experts and learners. The validators consist of three lecturers and four teachers who provide input based on the validation instruments that have been prepared. Input from validators is used to revise the module to reach an adequate eligibility category with a validation percentage of at least 80%. Measurement of the validity of the instrument's content can be done through the Aiken's V technique (Aiken, 1985).

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

Information:
V = instrument validity
S = r – lo
r = the number given by the assessor
lo = lowest validity rating number
n = number of raters
c = highest validity rating number

The validity of this research questionnaire is determined based on the values obtained during data collection. The criteria for assessing the correlation coefficient of questionnaire validity is shown in Table 1.

**Table 1.** Correlation coefficient of validity test

| Value Range V | Category of Validity |
|---|---|
| V < 0.40 | Invalid |
| 0.41 ≤ V < 0.60 | Quite Valid |
| 0.61 ≤ V < 0.80 | Valid |
| V ≥ 0.81 | Highly Valid |

Source: Aiken (1985)

Validation results in a second draft that has been corrected. Furthermore, a limited trial was carried out in groups of students (15 students from class 8D SMP Negeri 2 Balen Bojonegoro East Java (which was not the main research sample, but had similar characteristics) and 3 science teachers who were not validators. This trial aims to obtain initial feedback on the readability of the module (ease of understanding the text and instructions), as well as the practicality of using the module from the perspective of the student (ease of use, visual appeal, and clarity of the activity). Readability and practicality data were collected through student and teacher response questionnaires. The results of this limited trial are the basis for further revisions to the module. After revision based on a limited trial, the third module was produced, then a field test was carried out on a predetermined experimental group at random, namely class 8E SMP Negeri 2 Balen Bojonegoro, East Java. At this stage, PBL-STEAM-based science modules are implemented in real learning in class 8E. During the field trial, data on the effectiveness of the modules in improving students' science process skills was collected through pre-test and post-test test instruments. The data collected from all these stages is then analyzed using the N-Gain test to measure the improvement of students' science process skills. The n-gain score can be calculated by the formula (Sukarelawan et al., 2024):

$$< g >= \frac{Sf - Si}{Smax - Si} \quad (2)$$

Information:
<g> = normalized gain value
Sf = shoes posttest
Si = more of a pretest
Smax = maximum score

The calculated n-gain data is then analyzed with reference to Table 2 to identify the level of improvement in the ability of science process skills.

**Table 2.** Normalized gain criteria

| N-Gain Value | Interpretation |
|---|---|
| 0.70 ≤ g ≤ 100 | Tall |
| 0.30 ≤ g < 0.70 | Keep |
| 0.00 < g < 0.30 | Low |
| g = 0.00 | There is no improvement |
| -1.00 ≤ g < 0.00 | There is a decline |

Source: Sukarelawan et al. (2024)

## Results and Discussion

The results of the research are presented based on the 4D development stage, but up to the development stage that has been implemented, with a focus on the validity and effectiveness of the developed modules, while at the disseminate stage through scientific publications in journals (SINTA 2).

*Validation Test*

The PBL-STEAM-based science module validation process is carried out by applying the Aiken formula. This step is important to ensure that the module has a high content and construct validity, so that it meets the eligibility criteria for use in the context of research or learning activities. The validation of the PBL-STEAM-based science module involved a total of seven validators, including three lecturers and four education practitioners (teachers). The purpose of this validation is to ensure the accuracy of the concept, alignment with the curriculum, and the depth of material coverage of the simple machines. The validator's contribution in the form of constructive input and suggestions is then implemented in the revision of the draft module and test questions, which leads to the acquisition of draft II as a final product that is guaranteed quality and relevance.

*Subject Matter Expert Validation*

Material validation includes an assessment of the suitability of the material with the learning outcomes in the Merdeka curriculum, the depth of the material presented, the correctness of the concept in the presentation of the material, each activity presented has a clear learning objective, the relevance of the material to the PBL-STEAM concept, and the accuracy of facts and theories in the presentation of the material. The full results of this validation are presented in Table 3.

**Table 3.** Validation results of PBL-STEAM-based science module material experts

| Aspects assessed | Value V | Conclusion |
|---|---|---|
| Suitability of the material with learning outcomes in the Merdeka curriculum | 0.905 | Valid |
| The depth of the material presented | 0.857 | Valid |
| Truth of concept in the presentation of the material | 0.905 | Valid |
| Each activity presented has a clear learning objective | 0.905 | Valid |
| Relevance of the material to the PBL-STEAM concept | 0.905 | Valid |
| Accuracy of facts and theories in the presentation of the material | 0.905 | Valid |
| Average. | 0.897 | Valid |

With an average subject matter expert validation score of 0.897 (Table 3), it can be concluded that this material is valid and ready to use. Some suggestions for improvement have also been noted to improve some aspects. This high validity indicates the great potential of the material to be applied in the relevant learning or research context, after minor refinements are made based on expert input (Putri & Haikal, 2023).

*Linguist Validation*

Validation carried out by linguists includes evaluation of grammatical accuracy in accordance with Indonesian rules, consistency of writing scientific/foreign names, clarity of module structure, so that the material is easier to understand, quality of images, tables, and graphs, availability of examples and practice questions, and completeness of bibliography. The validation results can be seen in Table 4.

**Table 4.** Validation results of linguists of PBL-STEAM-based science module

| Aspects assessed | Value V | Conclusion |
|---|---|---|
| Grammatical accuracy in accordance with Indonesian rules | 0.905 | Valid |
| Consistency of writing scientific/foreign names | 0.905 | Valid |
| Clarity of module structure, so that the material is easier to understand | 0.857 | Valid |
| Quality of images, tables, and graphs | 0.857 | Valid |
| Availability of examples and practice questions | 0.905 | Valid |
| Bibliography completeness | 0.857 | Valid |
| Average | 0.881 | Valid |

Validation by linguists resulted in a V value of 0.881, indicating that the instrument was valid, with minor improvement recommendations from the validator. These findings suggest that the linguistic aspects of the instrument have been well tested, although some minor adjustments are required to improve perfection (Danuri & Maisaroh, 2019).

*Media Expert Validation*

Validation by media experts includes an assessment of the attractive and informative appearance of the module, effective layout, appropriate use of colors, and suitability of font size and typeface. Table 5 presents the validation results in detail.

**Table 5.** Validation results of PBL-STEAM-based science module media experts

| Aspects assessed | Value V | Conclusion |
|---|---|---|
| Interesting and informative module display | 0.857 | Valid |
| Effective layout | 0.857 | Valid |
| Use of appropriate colors | 0.905 | Valid |
| Font size and font suitability | 0.952 | Valid |
| Average | 0.893 | Valid |

Validation from media experts obtained an average V score of 0.893 (Table 5). This table proves that the validation is valid, with the note that there is improved input from media expert validators.

*Learning Expert Validation*

The validation results from the learning experts show two main areas of evaluation: the PBL-STEAM aspect and the overall module. For the PBL-STEAM aspect, the validation focuses on authentic problems that are relevant to daily life, there are enough opportunities for students to explore and investigate, harmonious integration of STEAM disciplines, creative and innovative products produced, and product and process evaluation criteria. Meanwhile, the overall module is assessed based on its ability to increase students' motivation to learn, improve students' science process skills, and improve students' understanding of simple machines concepts. More detailed information about the V value of this learning expert's validation results is available in Table 6.

**Table 6.** Validation results of PBL-STEAM-based science module learning experts

| Aspects assessed | Value V | Conclusion |
|---|---|---|
| Aspects of PBL-STEAM | | |
| The presence of authentic issues relevant to daily life | 0.857 | Valid |
| There are ample opportunities for students to explore and investigate | 0.857 | Valid |
| Harmonious integration of STEAM disciplines | 0.905 | Valid |
| The products produced are creative and innovative. | 0.857 | Valid |
| The existence of product and process evaluation criteria | 0.905 | Valid |
| Overall Modules | | |
| This module can increase students' motivation to learn | 0.905 | Valid |
| This module can improve students' science process skills | 0.952 | Valid |
| This module can improve students' understanding of the concept of a simple machines | 0.857 | Valid |
| Average | 0.887 | Valid |

Based on the data of the V value, all aspects of the learning module, both the PBL-STEAM aspect and the overall aspect of the module, show a valid category. With an average V value of 0.887, it can be concluded that this learning module is very valid and feasible to be used in the learning process.

A summary of the results of the validation of PBL-STEAM-based science modules by validators can be seen in Table 7.

**Table 7.** Results of validation of PBL-STEAM-based science module

| Validation Type | Average Value V | Conclusion |
|---|---|---|
| Material | 0.897 | Valid |
| Language | 0.881 | Valid |
| Media | 0.893 | Valid |
| Learning | 0.887 | Valid |
| Average | 0.890 | Valid |

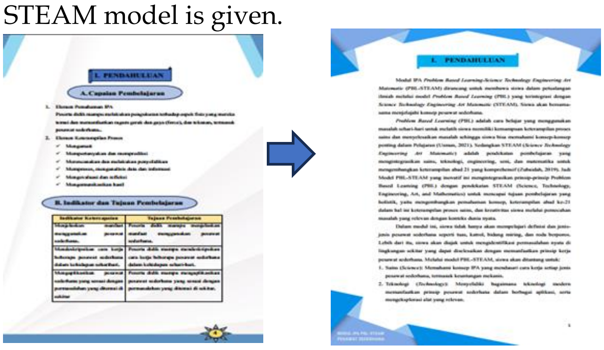
Based on Table 7, it can be concluded that overall this learning module is valid with an average V value of 0.890. This is supported by validation results in each aspect, namely material (0.897), language (0.881), media (0.893), and learning (0.887) which all show valid categories. This high validity shows that this module is feasible and ready to be used as an effective learning resource in the learning process. This feasibility is in line with the views of experts who state that an instrument or teaching material is said to be valid if it is able to measure or convey what should be measured or conveyed (Arikunto, 2010). Feedback from validators has been implemented to revise and improve the draft module. The changes made include the addition of an alternative cover image that is interesting, the inclusion of Francis pages, the explanation of the PBL-STEAM model based on the introduction chapter, modifications or illustrations on the module content map, the inclusion of image sources, the writing of quantities and numbering on tools and materials, the addition of titles to observation tables, and the addition of dots to the answer box in the activity sheet.

*Revision of Draft I*

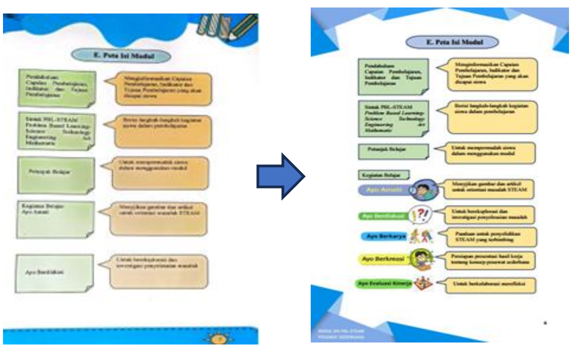
Validation input results by validators:

1. Alternative attractive images on the cover.


2. Add a francis page.
3. At the beginning of the introductory chapter, an additional explanation of STEAM based on the PBL-STEAM model is given.




4. Map of the contents of the module is illustrated or modified.




*Effectiveness Test*

After revision based on expert input, the module was tested on a limited basis to 15 students of class 8D and 3 science teachers by filling out a PBL-STEAM-based science module readability questionnaire. This trial aims to assess the readability and practicality of the module. The results of the analysis of the student and teacher response questionnaire are presented in Table 8, and show that the modules have a high level of readability, with the majority of students and teachers stating that the texts and instructions are easy to understand, as well as the layout of the modules attractive.

**Table 8.** Module readability questionnaire results

| Measured aspects | Readability Percentage (%) |
|---|---|
| Content Readability | 90 |
| Presentation Readability | 90 |
| Design Readability | 90 |

The assessment of the IPA PBL-STEAM module by science teachers and junior high school students (referring to Table 8) showed a module readability rate of 90%. This percentage indicates that the module is categorized as "very good" by the respondents, although there are several recommendations for improvement that need to be followed up, such as improving the quality of the print, completing material on simple machines, and the hope that this module will be printed through the publishing process and registered with Intellectual Property Rights (IPR), then the input is used to make further revisions, resulting in a third version of the module.

Furthermore, field trials were carried out in class 8E as an experimental group. PBL-STEAM-based science modules are implemented in the real learning process. To measure the effectiveness of the module in improving students' science process skills, pre-test and post-test measurements were carried out. The pre-test and post-test data presented in Table 9 were then analyzed using the N-Gain test.

**Table 9.** Science process skills test results

| Valuation | Pre-test | Post-test |
|---|---|---|
| Total score | 657 | 1329 |
| Average score | 43.8 | 88.6 |
| Total N-gain | | 12.0 |
| Average N-Gain | | 0.8 |

Based on the calculation of N-Gain, a value of 0.8 was obtained. Referring to Table 2 of the Normalized Gain Criteria, this N-Gain value is included in the High category. This indicates that the use of PBL-STEAM-based science modules significantly improves students' science process skills in grade 8E. This increase can be seen from the students' ability to formulate hypotheses, make observations, interpret data, and conclude experimental results.

This significant improvement can be attributed to the PBL approach that encourages students to be actively involved in real-world problem-solving, as well as the integration of STEAM that facilitates the development of 21st-century skills. Modules designed with experimental activities and collaborative projects have been proven to spark curiosity, encourage critical thinking, and train students' scientific communication skills.

The literature review related to the development of PBL and STEAM-based science modules was carried out by examining the results of previous research, especially those that focused on improving science process skills (SPS). Several relevant studies have underlined the effectiveness of this approach in honing various aspects of students' SPS. Research by Ramadhan et al. (2023) shows that the integration of PBL in science learning can significantly improve students' ability to formulate hypotheses, identify variables, and interpret data. They found that a problem-based approach encourages students to improve their scientific and systematic process skills in the face of scientific challenges. Meanwhile, according to Hamidi et al. (2024) observations show that all groups of students benefit significantly from the use of this PBL-based science module, which is directly effective in improving students' science process skills and making the learning process more meaningful and useful. This shows that PBL-based science modules not only enhance conceptual understanding, but also equip students with an important foundation for critical thinking and problem-solving that are relevant in scientific contexts and everyday life. In line with that, a study conducted by Filipe et al. (2024) highlights the role of STEAM elements in enriching the science learning experience, especially in the development of SPS. The incorporation of art (Art) in STEAM, for example, has been shown to increase students' creativity in designing experiments and presenting research results, which is an integral part of SPS. Meanwhile, the technology and engineering component in STEAM provides opportunities for students to apply scientific knowledge in a practical context, thus practicing their scientific observation, measurement, and communication skills. Furthermore, Chusna et al. (2024) in their research stated that learning modules designed with the PBL-STEAM approach are able to create a more authentic and relevant learning environment for students. This encourages students' active involvement in the scientific inquiry process, which in turn contributes to the improvement of science process skills i.e. observing, classifying, predicting, and communicating scientifically. Their findings suggest that this kind of module not only improves conceptual understanding, but also facilitates the internalization of SPSs through hands-on experience.

Overall, this literature review indicates that the development of science modules that integrate PBL and STEAM has great potential to holistically improve students' science process skills. Previous studies provide a strong theoretical and empirical foundation for the design of the modules to be developed, with a focus on creating stimulating and relevant learning experiences.

## Conclusion

The science module on simple machines, developed with the PBL-STEAM approach, has proven to be valid and effective in comprehensively improving students' science process skills. Nonetheless, there are some limitations that need to be considered. This study is limited to simple machines material, so generalization of results for other science materials may need further research. In addition, the effectiveness of this module is measured in the learning conditions at SMP Negeri 2 Balen, Bojonegoro Regency, East Java, which may be different in other school environments.

**Acknowledgments**

Thanks to all parties who have supported this research. I hope this research can be useful.

**Author Contributions**

Conceptualization, methodology, validation, formal analysis, investigation, resources, H.A.; data curation: writing—original draft preparation, S.S.; writing—review and editing, visualization, S. All authors have read and agreed to the published version of the manuscript.

**Funding**

Researchers independently funded this research.

**Conflicts of Interest**

The authors declare no conflict of interest.

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