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Sound Wave Teaching Module using STEM-PBL to Improve Students' Science Process Skills

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Abstract

Students' science process skills are still relatively low because the availability of learning resources such as teaching modules has not improved students' science process skills. Therefore, this study aims to analyze the feasibility of the STEM-PBL-oriented sound wave module to improve students' science process skills. This study uses the ADDIE model, which includes (1) analysis, (2) design, (3) development, and (4) implementation. The trial in this study used a one-group pre-test post-test design on 31 students at one of the state high schools in Banjarmasin City. Data collection was carried out through the validity and practicality of the module, which includes the teaching module and the implementation of the teaching module. The study results for the teaching module's validity value were (3.70 and 0.90) and the practicality value of the teaching module's implementation (was 3.36 and 0.68). Thus, the developed STEM-PBL-oriented sound wave teaching module can be implemented to improve students' science process skills, as seen from its high validity and practicality.

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INTRODUCTION

21st-century education requires students to have complex knowledge and high-level thinking skills, including the 4C competencies (Frananda et al., 2023; Muhali, 2019; Sijabat et al., 2023; Siswanto et al., 2023). Current education is education that implements an independent curriculum (Vhalery et al., 2022). The independent curriculum solves the challenges of global competition in the 21st century by developing the curriculum to shape students' character to face increasingly complex global dynamics (Amalia, 2022). One of the steps taken to achieve curriculum goals is to improve the quality of learning in schools (Ihsan et al., 2017; Telaumbanua, 2022).

Effective learning can help students expand their skills and understanding to achieve better results, where the learning process encourages active participation from students (Ernawati et al., 2022; Nurdyansyah & Fahyuni, 2016; Syarifudin, 2020; Yustanti & Novita, 2019). Physics learning is transferring information in the form of scientific products to students. Physics products are concepts, principles, theories, laws, equations, and science applications in technology and problem-solving (Aini et al., 2023; Fatmawati et al., 2024). Physics learning will be more meaningful and enjoyable if students get direct experience using scientific process skills to discover scientific products (Lusidawaty et al., 2020; Sideri & Skoumios, 2021). Science process skills refer to integrating scientific attitudes necessary to master the learning process in science (Dewantara et al., 2020; Gültekin & Altun, 2022;

Janah et al., 2018; Nadia et al., 2021). Science process skills are students' ability to conduct scientific investigations to understand, develop, and discover knowledge (Bangun et al., 2019; Hasanah & Utami, 2017; Lestari & Diana, 2018; Nurhuwaida et al., 2022). Science process skills are the development of physical and mental abilities that start from basic skills students possess and aim to develop their potential during the learning process. Students can experience and discover the meaning of physics learning (Lusidawaty et al., 2020). Science process skills include the skills that underlie every science learning activity (Desstya, 2015; Kurniawan et al., 2020; Zainuddin et al., 2020). Students can engage in science activities, conduct scientific investigations and STEM tasks, learn independently, and increase their responsibility in the learning process. Investigations encourage students to optimize the development of scientific process skills scientifically to deal with problems in everyday life (Janah et al., 2018; Nuraini & Waluyo, 2021; Putra et al., 2021). Applying science process skills in learning will influence students' achievements (Janah et al., 2018; Khairuna et al., 2021; Risda et al., 2023; Sholahuddın et al., 2020; Wulandari et al., 2023).

The researcher's initial observations at one of the State Senior High Schools in Banjarmasin City showed that students' science process skills were still low. The average value of students' science process skills was 15.7, which is considered not good. Many students are less active in receiving the material presented during the learning process. Most were silent when the teacher asked about their understanding of the material, while a few claimed to understand. This situation affects students' low science process skills. This is due to students' lack of active involvement in learning, so their science process skills are still weak in physics subjects (Wulan et al., 2024). Students also rarely do practical work in teaching and learning activities. Supported by research by Muzijah et al. (2020), during the learning process, students are rarely involved in meaningful experimental activities or activities that have a scientific investigation nuance, so they do not get the opportunity to develop their understanding.

The learning process carried out by teachers also tends to be teacher-centered. This means students rarely get to express their ideas individually or in groups. Teachers dominate the learning process with lectures and assume that information can be transferred directly. Teachers also deliver material too quickly or too slowly so that students who understand more quickly feel bored, while students who need more time feel rushed in learning. According to Sari et al. (2018), lecture and Q&A methods are ineffective enough to encourage all students to think and act. Cognitive abilities are still the focus of teacher assessment. Collecting information and concepts without a basis in scientific investigation makes students only memorize without really understanding the material being studied (Lusidawaty et al., 2020; Mutmainnah, 2023). Teachers also have not trained and measured students' science process skills properly. This causes students to be passive in learning, only listening without actively participating, which has an impact on the lack of creativity development or even causes them not to be creative and also has an impact on low student learning achievement in physics subjects (Salay, 2019). In addition, the limited teaching modules available to improve students' science process skills, especially regarding sound waves, are also a factor in their low science process skills.

One solution to the above problems requires innovation by developing teaching materials in the form of physics modules using Problem-Based Learning combined with STEM. STEM-PBL is 21st-century learning (Ariyatun & Octavianelis, 2020). PBL is learning that involves real-life problems as a context for high-level thinking and problem-solving skills (Dita et al., 2021; Elizabeth & Sigahitong, 2018; Srikan et al., 2021). PBL helps students develop skills to identify problems and work together to solve real problems that arise from everyday life during the learning process (Hasanah et al., 2021; Putri, 2023; Septiani et al., 2020; Yuberti et al., 2019). Physics learning is closely related to technology.

STEM integrates interrelated disciplines (AlAli, 2024; Norlaili et al., 2022; Ormancı, 2020). Mathematics is applied in science to analyze data, while technology and engineering are applications of scientific knowledge (Adiwiguna et al., 2019). To increase competitiveness in the modern era, STEM-oriented Physics learning is very necessary (Utami et al., 2023; Wahono et al., 2020). STEM-integrated learning encourages students to develop high-level thinking skills and utilize technology as capital for life in the future (Hartini et al., 2020; Wahono et al., 2020). The STEM approach in Physics learning is expected to bring meaningful innovation to students by systematically integrating knowledge, concepts, and skills (Ariyatun & Octavianelis, 2020; Saputri et al., 2023; Septiani et al., 2020).

STEM-PBL is learning that involves authentic, complex, and meaningful problems; various disciplines, scientific inquiry, collaborative work; producing work and exhibiting it (Hasanah et al., 2021; Putri et al., 2021; Suyidno et al., 2022). STEM-PBL, as a learning strategy that can facilitate low and high levels of learning, encourages students to actively participate in solving the problems given, indirectly stimulating their interest in learning, thus helping to recognize the value of scientific knowledge in finding solutions (Bakri et al., 2021; Topsakal et al., 2022).

Physics learning using STEM-PBL for students emphasizes the problems that have been set so that they not only learn the concepts related to the problem but also understand the scientific methods to solve it (Akcanca, 2020; Suciana & Sausan, 2023). One use of STEM-PBL learning can be implemented through the use of teaching materials, modules, or learning videos (Vikayatri et al., 2023; Widiyatmoko & Darmawan, 2023). The learning process requires a module so students can learn independently (Malina et al., 2021). A module is a learning plan that is designed according to the stages of student development, considering learning objectives and based on long-term development (Setiawan et al., 2022). The use of modules is expected to increase students' interest in learning and ultimately achieve the objectives set (Aransyah et al., 2023; Lewedalu, 2018). Integrating STEM-PBL in the module also allows students to learn independently to practice finding problems, analyzing problems, making hypotheses, and finding solutions. Integrating STEM-PBL in the sound wave module can also train science process skills. Students need to master basic skills in learning physics, which are then presented through learning modules to support the development of science process skills independently (Jumadi et al., 2018). Based on the existing problems, this research aims to produce a STEM-PBL teaching module on sound wave material suitable for improving students' science process skills.

METHODS

This type of research is development research using the ADDIE model. The ADDIE model used in this study uses only four steps, namely: (1) analysis, (2) design, (3) development, and (4) implementation. Meanwhile, the evaluation stage was not carried out considering the research implementation schedule with the school that did not allow it; thus, it is a recommendation for further research from this study. The development stages used can be seen in Figure 1.

The resulting product is a STEM-PBL sound wave module to improve students' science process skills. The feasibility of this product is determined based on its validity and practicality. Validity refers to the extent to which a measuring instrument can provide accurate measurement results in accordance with the objectives to be achieved (Suseno, 2014).

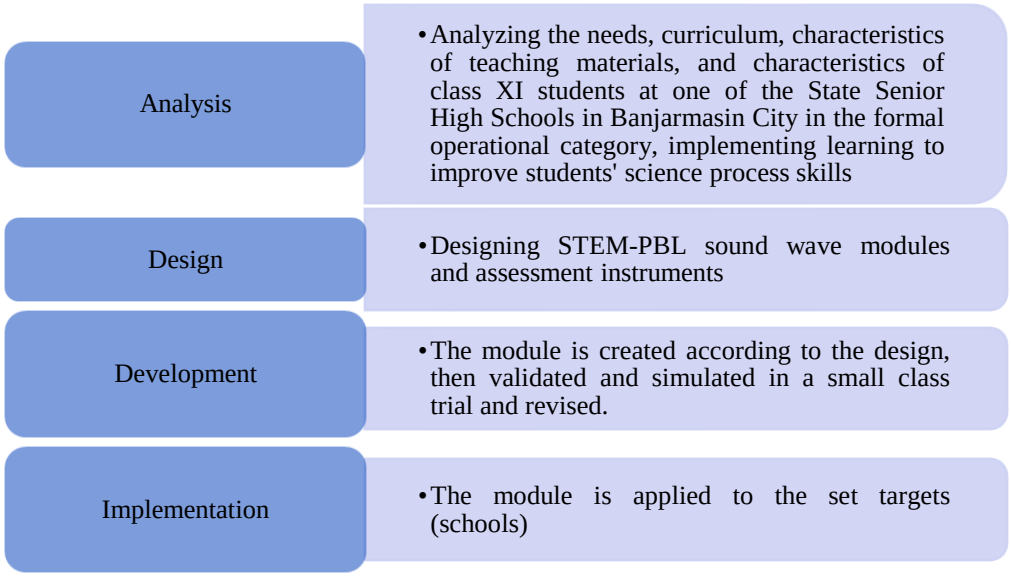

Figure 1 Stages of the ADDIE development model

The instrument measures exactly what is meant and accurately describes the data from the variables studied (Eunike et al., 2022). The validity of a product is determined through an assessment by many experts. The goal is to ensure that the product assessment is consistent and accountable. The validity of the teaching module is reviewed based on the module cover design, general information, core components, meeting list details, teaching materials, and student worksheets. Table 1 is a reference for validation criteria and practicality.

Table 1 Categorization intervals

Interval	Category
$X_i + 1.8 \times s_{bi} < X$	Very good
$X_i + 0.6 \times s_{bi} < X \leq 1.8 \times s_{bi}$	Good
$X_i - 0.6 \times s_{bi} < X \leq X + 0.6 \times s_{bi}$	Moderate
$X_i - 1.8 \times s_{bi} < X \leq X - 0.6 \times s_{bi}$	Poor
$X \leq X_i - 1.8 \times s_{bi}$	Very poor

(Widoyoko, 2016)

Table 2 shows the module validity criteria using a maximum scale of 4 and a minimum scale of 1.

Table 2 Validity criteria

Range	Category
$X > 3.4$	Very valid
$2.8 < X \leq 3.4$	Valid
$2.2 < X \leq 2.8$	Enough
$1.6 < X \leq 2.2$	Less valid
$X \leq 1.6$	Invalid

(Adapted from Widoyoko, 2016)

The data from the teaching module validation conducted by three validators were tested for reliability as an equalization of scores between validators calculated using the H. J. X Fernandes agreement coefficient formula (Arikunto, 2014). The reliability category of the validated module assessment was determined by comparing the results of the reliability calculations obtained with the reliability criteria in Table 3.

Table 3 Reliability criteria

Reliability Criteria	Category
$0.8 < r_{11} \leq 1.0$	Very good
$0.6 < r_{11} \leq 0.8$	Good
$0.4 < r_{11} \leq 0.6$	Enough
$0.2 < r_{11} \leq 0.4$	Poor
$0.0 < r_{11} \leq 0.2$	Very poor

(Adapted Arikunto, 2014)

Three observers review the module's practicality from the module implementation sheet. The value obtained from the average score is used to determine the practicality category by comparing it with the practicality criteria of the teaching module in Table 4.

Table 4 Practicality criteria

Range	Category
$X > 3.2$	Very practical
$2.4 < X \leq 3.2$	Practical
$1.6 < X \leq 2.4$	Enough
$0.8 < X \leq 1.6$	Less practical
$X \leq 0.8$	Not practical

(Adaptasi Widoyoko, 2016)

RESULTS AND DISCUSSION

Validation is obtaining approval or ratifying a device based on an evaluation of the established criteria. Previously, this module went through a validation process by academic experts and practitioners to assess validity, which was then simulated and tested in class to produce a valid and practical teaching module. The following is the cover of the STEM-PBL sound wave module, which can be seen in Figure 2.

Figure 2 Cover of the STEM-PBL sound wave teaching module

The results of the validation of the developed teaching module can be seen in Table 5, which shows the validity and reliability values of the teaching module assessed by two expert validators and one practitioner validator.

Table 5 Results of module validity and reliability

	Validity Review Aspects of Teaching Modules	Average	Category
1.	Module cover design	**3.66**	Very valid
2.	General information	**3.85**	Very valid
3.	Core component	**3.41**	Very valid
4.	Detail of meeting list	**3.80**	Very valid
5.	Subject material and student worksheets	**3.76**	Very valid
Validity		3.70	Very valid
Reliability		0.90	Very valid

The developed teaching module is the STEM-PBL sound wave module, designed to improve students' science process skills following the independent curriculum and is adjusted to school needs. The validity of the teaching module is reviewed based on the module cover design, general information, core components, meeting list details, teaching material attachments, and student worksheets. Based on the validator's suggestions and input, this module was revised according to the input. In relation to field conditions, namely the low science process skills of students, it is necessary to implement constructivist learning, which aims to help students explore topics and generalize knowledge. To improve students' skills in exploring issues and applying knowledge in general, efforts are needed to develop creative teaching modules.

The presentation component of the module's appearance is categorized as very valid. Teaching material can be interesting if it uses images and illustrations that are able to clarify the contents of the material to students (Maghfiroh & Susantini, 2023). The design of the teaching module needs to consider more than just the content, namely, the need to pay attention to the visual aspect, especially the module cover. This teaching module is designed with an attractive form, considering the color of the text, font, and background to meet the aesthetic and functional aspects. The goal is to make it easier for students to learn. Using the right font is important because each font has certain characteristics, functions, and meanings that affect understanding and reduce the possibility of misunderstanding (Syahrul, 2019). The cover of the developed teaching module is predominantly blue, with the color of the letters on the title in black. The combination of colors and backgrounds is designed to be comfortable and easy to read, producing an attractive appearance and increasing students' interest in reading (Mumpuni, 2019). In addition, on the cover are pictures of people talking, ultrasound devices, and various musical instruments. The meaning of the picture of people talking is to convey the message that the module's contents are related to sound wave material. The ultrasound device provides a message that the module contains the application of sound waves in the field of technology, and musical instruments provide a message about the application of sound waves in everyday life.

The next component is general information, which is categorized as very valid. The teaching module developed using the STEM-PBL model includes a general description of the module, the P3 dimensions to be achieved through learning, facilities, and infrastructure to support the entire learning process, target students, and the selection of learning methods or strategies. The general information component based on the Merdeka curriculum includes module identity, initial competencies, P3, facilities and infrastructure, target students, learning models, and remedial and enrichment (Rahmadayanti & Hartoyo, 2022).

The core components reviewed from the linguistic feasibility and suitability of the material are categorized as very valid. The language aspects in this teaching module include using grammar and spelling in accordance with good and correct language rules, clear and structured language, and appropriate terms, punctuation, and physics symbols (Asri & Dwiningsih, 2022). The language in this module is designed to follow the rules of language, be regular, and be communicative. Communicative language means language that fulfills

the function of communication so that the reader can easily understand it (Yastini et al., 2018). Use of vocabulary and application of punctuation so that the meaning of the writing can be conveyed clearly (Sukirman, 2020). Next, the material should be suitable for learning objectives and the concept of sound waves. According to Arsyad (2014), the learning media must focus on the objectives achieved after learning is completed. Therefore, the media needs to be adjusted to the learning objectives to make the learning process more meaningful (Siagian & Yasthophi, 2021).

The detailed component of the meeting list is categorized as very valid. The validity results of the sub-components show conformity with the formulation of the learning objective flow and the learning model used. Therefore, the preparation of teaching modules must be interrelated and structured, in accordance with the curriculum, and relevant to learning objectives (Jannah, 2019). The learning steps are implemented through preliminary, core, and closing stages, with clear time allocation for each stage according to STEM-PBL. In addition, a complete evaluation instrument is used to improve students' science process skills. The KPS indicators that will be observed in this study include (1) orienting students to problems, (2) organizing students to learn, (3) assisting independent and group investigations, (4) developing or presenting work results and exhibiting them, and (5) analyzing and evaluating the problem-solving process. The STEM-PBL-based module is designed with unique characteristics to develop students' science process skills. This interdisciplinary module combines STEM concepts and problem-based learning approaches, thus encouraging students to think critically and creatively when solving real problems. Some of its main characteristics include a focus on authentic problems, a project-based approach, and applying science concepts in everyday life. In addition, this module is also designed to stimulate exploration and investigation through experiments and data-based discussions, which train observation skills, data analysis, and logical conclusion drawing. By adopting the STEM-PBL approach, students gain a theoretical understanding of science concepts and can apply them in innovative solutions in various fields of technology and engineering. This approach makes the learning process more meaningful, strengthens higher-order thinking skills, and increases independence and the ability to work together in a learning environment.

The teaching material and student worksheet components are categorized as very valid. The teaching material contains (1) teaching material cover, (2) material table of contents, (3) material introduction, (4) usage instructions, (5) information on the KPS indicators studied, (6) concept maps, (7) material descriptions, (8) let us think activities, (9) physics treasury, (10) example questions, (11) example KPS activities, (12) summary, (13) evaluation questions, (14) glossary, (15) bibliography, and 16) answer key. The special characteristic of the teaching material is the content of science process skills presented in each sub-chapter of the learning material. The purpose of this approach is so that when students learn independently, they can develop their thinking and understanding of science. Students will think about their knowledge and what they will learn next. Thus, the teaching material drives the development of students' thinking levels in science (Dewi & Ibrahim, 2019).

The developed student worksheet is designed to achieve learning objectives aimed at improving students' science process skills in sound wave material, which includes the title of the material studied, problem orientation, experiment objectives, formulating problems, formulating hypotheses, identifying variables, tools, and materials used, designing experiments, recording observation results and analyzing data, concluding and consolidating. A student worksheet is considered valid if it meets three criteria, namely didactic requirements, construction requirements, and technical requirements (Salimah et al., 2019).

Based on Table 5, the average results show that the teaching module is very valid and highly reliable. This shows that the STEM-PBL-based sound wave module developed is suitable for use in research to improve students' science process skills. Developing teaching modules is an important skill for educators, ensuring that the learning process runs efficiently, effectively, and in accordance with the objectives set (Ali & Syamsurizal, 2024; Mayangsari et al., 2024). In addition, along with the development of the era towards the 21st century, it is expected that educators can prepare students with skills to face various global challenges. It is expected that learning outcomes will not only provide an understanding of concepts or materials but also provide experience and preparation for students to face real-life challenges around them. The development of this STEM-PBL teaching module is expected to be an effective tool in training students' science process skills.

According to Nieveen (2007), the validity of a teaching module can be assessed from two main aspects: first, whether the curriculum or model developed is based on current knowledge, and second, whether the various components in the teaching module are consistently connected. The teaching module must be based on relevant knowledge (content validity), and its components must be consistently interrelated (construct validity). If the teaching module meets both aspects, then the teaching module is considered valid. The validator will evaluate the developed teaching module. If it meets all the criteria, the results of the validator's assessment will determine whether the teaching module is suitable for use, either with or without revision, based on a strong theoretical basis. The assessment of the feasibility of the teaching module is based on four aspects determined by BSNP, namely the feasibility of content, language, presentation, and graphics (Purboningsih, 2015).

The development module has consistency across all aspects evaluated, and each module component is interconnected with each other. The validity results are in line with previous research, such as the research of Suyidno et al. (2022), who built a module utilizing STEM-PBL and found that the module was valid. Therefore, the teaching module functions as a guide for students' autonomous learning and teachers' learning.

The validated teaching module will then be tested in class. The practicality of the teaching module is measured from the results of the learning implementation designed for four meetings. The STEM-PBL design is directed at solving real-life problems, with students actively involved in the STEM thinking process to plan and implement solutions (Suyidno et al., 2021). The following is the practicality of the module, which can be seen in Table 6.

Table 6 Results of the practicality of the teaching module

Learning activities	**1st Meeting**		**2nd Metting**		**3rd Meeting**		**4th Meeting**	
	Value	**Category**	**Value**	**Category**	**Value**	**Category**	**Value**	**Category**
Orienting students to the problem	3.60	VP	3.66	VP	3.46	VP	3.60	VP
Organizing students to learn	3.55	VP	3.22	P	3.66	VP	3.33	VP
Assisting with independent and group investigations	3.55	VP	3.33	VP	3.33	VP		
Developing and/or presenting work results and exhibit them	2.66	P	3.00	P	2.66	P	3.50	VP

Learning activities	1st Meeting		2nd Metting		3rd Meeting		4th Meeting	
	Value	Category	Value	Category	Value	Category	Value	Category
Analyzing and evaluating the problem-solving process	3.50	VP	3.33	VP	3.58	VP	3.33	VP
Average per meeting	3.37	VP	3.31	VP	3.34	VP	3.44	VP
Reliability	0.68	High	0.63	High	0.75	High	0.68	High

The results of the percentage of learning implementation for each phase in four meetings are presented above the average meeting in the very practical category and reliability in the high category. Analysis of learning implementation can be used to measure how practical the training module is (Sirate & Ramadhana, 2017; Triantoro, 2022). Three observers observed how this learning was practiced. When educators and learners considered the learning module easy to use and functional, then the module was considered practical. A learning module is practical if there is coherence between the curriculum and the learning process (Purboningsih, 2015; Subakti et al., 2021). The user perspective is applied to the practicality aspect: The practicality aspect is assessed based on two main factors: first, whether experts and practitioners assess that the developed product can be used under normal conditions; second, whether practical experience shows that the product can be applied effectively by teachers and learners (Fauzi et al., 2024; Subakti et al., 2021).

Table 6 shows that the average meeting of learning activities in this study is classified as very practical, indicating that the activities are carried out according to very good standards and suitable for observing learning implementation activities. In addition, learning activities are given as an average value for each category. The table above shows how teachers use the introduction, core, and closing elements of STEM-PBL-oriented physics tasks to improve science process skills.

Phase 1: Teachers physically and psychologically prepare students (Suyidno et al., 2021). Students participate in greetings, prayers, perceptions, listening, and viewing STEM videos about sound waves that provide motivational phenomena. Teachers can utilize videos as audio-visual media to engage students because videos can be seen and heard, thus attracting their attention in the learning process (Suyidno et al., 2022). Using videos in the classroom can encourage students to be more involved as long as they are used appropriately and are related to the subject matter being discussed (Syaparuddin & Elihami, 2020). After the video is shown, students are encouraged to ask many scientific questions.

In phase 2, the teacher organizes students in learning; in this phase, the teacher checks students' mastery of the material through a question-and-answer discussion. With this method, teachers can more effectively evaluate students' understanding and motivate them to participate actively in every learning activity (Misbah, 2022). Students are then directed to form groups, and group representatives take student worksheets and ask the group to solve problems through experiments or investigations.

In phase 3, the teacher guides students in a discussion to answer questions contained in the student worksheet. Students are asked to formulate scientific questions or formulate problems based on the sound wave phenomenon that has been presented. Furthermore, students formulate hypotheses and identify variables based on observations. Then, plan a practicum (design experiments, analyze data, and conclude data) with student worksheet guidance. Students carry out the practicum according to the plan they have designed. In this exercise, the instructor verifies the accuracy of the data collected, then connects the idea to the selected issue and makes conclusions. The teacher facilitates group discussions to develop noise pollution designs at the third meeting. To obtain information from various sources and ask questions to consider challenges and find solutions, students collect data

and understand problem scenarios. In this context, educators create a democratic, open, and supportive learning environment, thus encouraging the inquiry process according to needs (Suyidno et al., 2022). At first, students had difficulty formulating problems or writing scientific questions about the sound wave phenomenon presented. They also faced difficulties in identifying and recording concepts to answer questions, especially in linking these concepts to practices that had been carried out. Therefore, the teacher tried to provide additional attention to help students overcome these obstacles.

In Phase 4, students presented their performance results in front of the class and held discussions about material that was still not understood (Surya, 2017). Students submit data from their practicum results and, at meeting 4, present a design to reduce noise pollution. In phase 5, Students are active in the evaluation and reflection process and complete the consolidation task independently at the end of the student worksheet. This reflective evaluation supports the achievement of learning objectives and the success of the learning process in the classroom. The teacher's success in guiding STEM-PBL activities is reflected in students' positive responses, as shown in Table 5.

In an effort to improve the results at the next meeting, the teacher developed a strategy to overcome several challenges that emerged at the first meeting. Based on the discussion results, the following solution designs will be offered: 1) provide appropriate instructions and models for students to create problems and hypotheses with the hope that they can understand each step of STEM-PBL. 2) The teacher guides and inspires students to divide work into groups to use time efficiently. 3) The teacher provides careful observation and encouragement to each group so that each student fully participates in direct learning.

The reflection results at the first meeting are used to consider implementing learning activities at the next meeting. Implementing learning activities with this teaching module can benefit from the improvements developed. In line with Pratama (2019) research, the modules developed for students are practical to be used in the learning process. Practicality is a quality criterion for teaching modules that is always present in each phase. The practicality aspect is a quality criterion for modules that is seen from the level of ease for teachers and students in implementing the modules developed in the learning process (Putri & Guspatni, 2024).

CONCLUSION

This study produced a STEM-PBL-oriented sound wave teaching module to improve students' science process skills. The results of the study for the validity and reliability values of the teaching module of 3.70 and 0.90 are in the very valid category with a high level of reliability; the practicality and reliability values of the implementation of the teaching module are 3.36 and 0.68, which are in the very practical category with a high level of reliability. Thus, the STEM-PBL-oriented sound wave teaching module that was developed can be implemented effectively to improve students' science process skills, as seen from the results of its high validity and practicality. In STEM-PBL learning, students also produce products in the form of designs in accordance with the sound wave material, but several groups create product ideas that are designed almost the same. This module can be a reference for developing similar teaching materials focusing on problem-based and project-based learning, especially to improve students' science process skills.

CONFLICTS OF INTEREST

All authors declare that they have no conflicts of interest.

AUTHOR CONTRIBUTIONS STATEMENT

This article was prepared based on collaboration with each author. SK and SS as conceptual designers and research methodology. SM as a literature review and further refinement of the resulting data. QQ managed the writing and editing process to ensure clarity and consistency in the research. Furthermore, SS reviewed and approved the final manuscript to ensure the accuracy of the results of the module development in improving science process skills.

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