

The Use of Problem Posing Type Post Solution Posing Model in The Development of Learning Materials to Improve Students' Problem Solving Skills

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Abstract: Problem solving skills are one of the essential competencies possessed by a student. This study aims to develop learning material that can improve students' problem solving skills in the work and energy topic. The learning material was developed by following the problem-posing type post-solution posing principle. The development research method used is 4D (define, design, develop, and disseminate). However, the development process in this study was limited to the development stage, including expert appraisal and developmental testing. The participants of the research were 43 senior high school students. The research instruments used were a questionnaire validity sheet, a practicality sheet, and a problem-solving test. The evaluation results of the learning material feasibility were considered very feasible based on the assessment of 12 experts, who were divided into three learning design experts, three linguists, three media experts, and three material experts. The tested learning material demonstrated preliminary effectiveness in improving students' problem-solving skills, with an N-gain of 0.43 in the moderate category. The results of the practicality of the learning material on student responses obtained a score of 84.72% in the very good category, and based on the three responses from the physics teacher, obtained a score of 91.67% in the very good category. The results in this study can be used as a reference in developing learning material on other physics topics.

Keywords: Learning material development, problem posing, post solution, problem solving skills

Introduction

Problem-solving skills are an essential part of higher-order thinking skills that constitute a primary goal of 21st-century learning (Rehman et al., 2025; Wulandari, 2021). In physics education, National Science Teachers Association in Collaboration with the Association for the Education of Teachers in Science (NSTA) (2003) emphasizes that problem-solving skills are an essential aspect that must be developed. Problem solving is viewed as a holistic process because physics problems are closely related to real-life phenomena and everyday contexts (Purwaningsih et al., 2020; Rosa, 2015). Work and energy are one of the physics topics that strongly requires these skills because it involves the relationship among force, displacement, work, kinetic energy, potential energy, and the conservation of mechanical energy.

Students often experience difficulties in solving problems related to work and energy. Previous studies have shown that students' problem-solving skills on the topic of work and energy remain low (Miranti et al., 2022; Rufaida & Sujiono, 2013). This finding is consistent with preliminary observations conducted in several public senior high schools in South Tangerang, which showed that many students found work and energy difficult to understand. Students were generally able to solve routine problems, but they encountered difficulties when the same concepts were presented in different contexts. This condition indicates that physics learning still tends to emphasize declarative knowledge and routine exercises rather than systematic training in problem-solving processes.

The limited ability to apply concepts directly affects students' problem-solving skills and learning outcomes (Amanah et al., 2017; Tong et al., 2025). Students need strong conceptual understanding, the ability to connect related concepts, and the capacity to select solution strategies that match the characteristics of a problem (Jäder & Johansson, 2025). Therefore, physics learning needs instructional support that guides students to actively construct knowledge and apply it in varied problem situations. One

strategic form of support is the development of instructional materials designed to promote structured, meaningful learning activities (Alismail & McGuire, 2015). Instructional materials help students acquire information, develop conceptual understanding, gain learning experiences, and practice specific skills (Daryanto, 2013; Rahmi et al., 2025).

Modules are relevant instructional materials for supporting problem-solving skills because they provide clear learning sequences, support self-directed learning, and promote student-centered activities (Al Farizi et al., 2023; Rivai & Rahmawati, 2025; Silver & Cai, 1996). Previous studies on physics module development have generally reported positive results in terms of validity, practicality, readability, and learning outcomes (Alatas et al., 2023; Noviana et al., 2022; Suryadi et al., 2024; Yuyun et al., 2022). Nevertheless, the development of modules that explicitly target problem-solving skills through activities involving the formulation or modification of problems remains relatively limited, especially on the topic of work and energy. In fact, this topic requires the ability to connect physics concepts with a wide range of contextual situations.

Problem posing offers a relevant approach for addressing this limitation because it engages students in both formulating and solving problems. In problem-posing activities, students are encouraged to generate questions, modify existing problems, and examine the relationship among known variables, target variables, and relevant concepts. This process can support deeper conceptual understanding and strengthen students' ability to solve problems (Hudha et al., 2017; Kusumawati, 2014). Students who formulate or modify problems are required to analyze conceptual structures, evaluate the quality of the problems they create, and reflect on the solution process.

Problem posing can be classified into three forms of cognitive activity: pre-solution posing, within-solution posing, and post-solution posing (Silver & Cai, 1996). In pre-solution posing, students generate problems from a given situation before solving them. In within-solution posing, students reformulate a problem or create sub-questions during the solution process. In post-solution posing, students modify the goals, conditions, or variables of a problem that has already been solved to create a new problem of a similar type. Although problem posing was originally developed in mathematics education, its principles can be adapted to physics learning because students also need to recognize problem structures, identify relevant concepts, and construct meaningful questions (Brown & Walter, 1990; English, 1997).

Post-solution posing is particularly suitable for learning work and energy because this topic requires students to understand how changes in force, displacement, height, mass, velocity, and energy affect the solution process. In post-solution posing activities, students first analyze a solved problem, then modify its conditions, goals, or known variables, and finally solve the new problem they have created (Hartmann et al., 2023; Pratama et al., 2017). This process can help students understand the structure of the original problem, identify relevant physics principles, connect concepts with mathematical representations, and apply solution strategies in a new context. Through this activity, students are not only trained to obtain answers, but also to understand how a problem is constructed and how a solution strategy can change when problem conditions are modified. In addition, students' ability to construct or modify problems in problem-posing learning has been reported to be positively correlated with problem-solving skills (Kusumawati, 2014).

Despite the recognized benefits of problem posing, its integration into physics instructional materials, particularly in work and energy, remains limited. Existing modules generally emphasize concept mastery and routine exercises, while structured activities that require students to analyze solved problems, modify problem conditions, generate new problems, and evaluate alternative solution strategies are less frequently incorporated. This study emphasizes the explicit integration of post-solution posing activities into a work and energy module and the alignment of these activities with specific indicators of problem-solving skills. This study contributes a module design that connects problem posing activities with the stages of physics problem solving, namely understanding the problem, representing the problem using physics concepts, planning and applying solution strategies, and evaluating outcomes.

The need for developing this module is further supported by preliminary observation data showing that students perceived physics learning as easier to understand when accompanied by problem-solving exercises and varied examples. Based on these empirical problems and theoretical considerations, the development of a physics module based on post-solution posing is considered relevant for supporting Grade X physics learning. This study aims to produce a physics module on work and energy that meets the criteria of validity, practicality, and preliminary effectiveness in improving students' problem-solving skills.

Methods

Research Design

This study employed a Research and Development (R&D) approach. The method was used to produce an instructional product in the form of a physics module based on problem posing of the post-solution posing type for the topic of work and energy for Grade X students. The development model adopted was the 4D model proposed by Thiagarajan, et al. (1974), which consists of four stages: define, design, develop, and disseminate. In this study, the development process was limited to the define, design, and develop stages. The dissemination stage was not conducted because this research focused on creating the module, validating its feasibility, examining its practicality, and testing its initial effectiveness in a limited classroom context. Wider dissemination can be conducted in future studies.

Research Site and Participants

The study was conducted at a senior high school in South Tangerang. The trial participants consisted of 43 students from Grade X MIPA 4. Participants were selected using a purposive sampling method because the class represented the target users of the developed module and was available for product trial implementation. The class was also selected based on teacher recommendations because the students had heterogeneous academic abilities and were studying work and energy topics during the study period.

The practicality assessment involved three physics teachers. The teachers were selected because they taught physics at the senior high school level and had experience teaching the topic of work and energy. Their involvement was intended to obtain professional judgment regarding the usability, clarity, relevance, and classroom applicability of the developed module.

Product validation was carried out by 12 validators, comprising three instructional design experts, three language experts, three media experts, and three subject-matter experts. The validators were selected based on their expertise in instructional design, language use in learning materials, educational media, and physics content. Their judgments were used to determine the feasibility of the module before it was tested with students.

Development Procedure

The steps of the development research are illustrated in Figure 1.

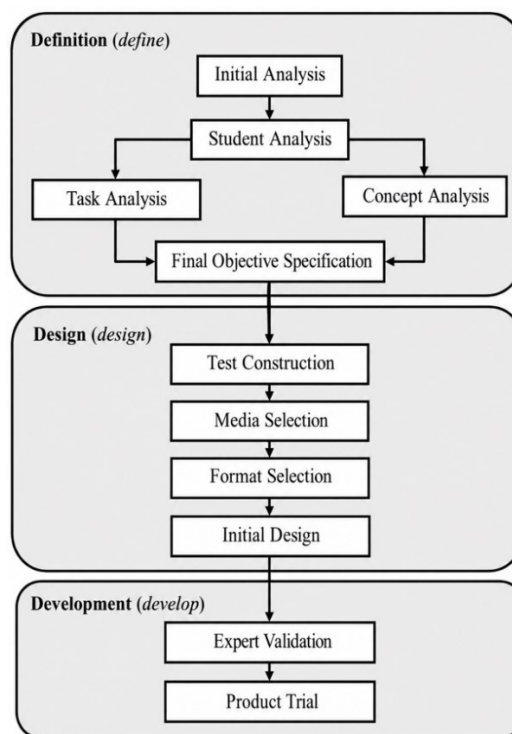


Figure 1. Development stages

The define stage consisted of a literature review and a field study. The literature review examined curriculum documents, previous studies on work and energy learning, problem-solving skills, instructional material development, and problem posing. The field study was conducted through observations and preliminary questionnaires involving students and physics teachers. This stage identified students' difficulties in learning work and energy, the limitations of existing instructional materials, and the need for learning activities that could support problem-solving skills.

The design stage produced the initial draft of the module. This stage included the formulation of learning objectives, preparation of module components, selection of learning activities, development of problem-solving tasks, and construction of assessment instruments. The module was designed to integrate post-solution posing activities into the topic of work and energy. The initial draft included an introduction, learning instructions, concept explanations, solved examples, post-solution posing tasks, exercises, reflection activities, and evaluation questions.

The develop stage consisted of expert appraisal and developmental testing. Expert appraisal was conducted to evaluate the feasibility of the module in terms of instructional design, language, media, and content. The module was revised based on expert suggestions before the classroom trial. Developmental testing was then conducted to examine the practicality and preliminary effectiveness of the module in Grade X physics learning.

Product Trial Design

The preliminary effectiveness test employed a one-group pretest–post-test design. Students were given a pretest before using the module and a post-test after learning with the module. Practicality testing was conducted using student response questionnaires and teacher response questionnaires after implementation.

The implementation of Post Solution Posing in this study follows several learning stages. First, the teacher explains the learning objectives. Second, students are divided into heterogeneous small groups consisting of five to six members. Third, each group summarizes the learning material provided by the teacher. Fourth, each group modifies the problem on the first problem-posing worksheet and writes the answer. Fifth, the problems created by each group are exchanged with other groups. Sixth, each group discusses the problems received from another group and writes the answers on the second problem-posing worksheet. Seventh, the first worksheet is returned to the original group, while both worksheets are submitted to the teacher. Finally, each group presents its summary and the problems obtained from another group. Through these stages, students are guided to construct, modify, discuss, and solve physics problems in a more active and structured learning process.

Research Instruments

The research instruments consisted of expert validation sheets, practicality questionnaires, and a problem-solving skills test. The expert validation sheets were used to assess the feasibility of the module. The instructional design validation sheet assessed the suitability of learning objectives, learning sequence, learning activities, and assessment design. The language validation sheet assessed clarity, readability, communicativeness, consistency of terms, and suitability of language for Grade X students. The media validation sheet assessed layout, visual appearance, typography, illustration, and usability. The content validation sheet assessed conceptual accuracy, relevance to curriculum, depth of material, suitability of examples, and alignment between learning activities and problem-solving indicators.

The practicality questionnaires were used to collect student and teacher responses after the module implementation. The student response questionnaire assessed ease of use, attractiveness, content clarity, and language clarity. The teacher response questionnaire assessed ease of implementation, relevance of content, clarity of instructions, attractiveness, and suitability of the module for classroom learning.

The problem-solving skills test consisted of five essay questions on work and energy. The questions were developed based on five indicators of problem-solving skills, namely understanding the problem, describing the problem using physics concepts, planning the solution, applying the solution, and evaluating the solution. Each item was scored using an analytic rubric. The rubric enabled the researcher to evaluate not only the final answer, but also the process used by students in identifying information, selecting concepts, planning strategies, applying equations, and checking the reasonableness of their answers.

Data Analysis

The data were analyzed using descriptive quantitative techniques. Expert validation scores were converted into percentages by dividing the obtained score by the maximum score and multiplying the result by 100. The percentage scores were then interpreted into feasibility categories. A module was considered valid if the validation result reached at least the feasible category.

Student and teacher response scores were also converted into percentages. These percentages were interpreted into practicality categories. The module was considered practical if the student and teacher response scores reached at least the practical category. Qualitative comments from validators and teachers were used to revise and refine the module.

The improvement of students' problem-solving skills was analyzed using the normalized gain score. The N-gain score was calculated by comparing students' pretest and post-test scores. The N-gain value was interpreted using the criteria proposed by Hake (1998), namely low if g was less than 0.30, moderate if g was equal to or greater than 0.30 and less than 0.70, and high if g was equal to or greater than 0.70. The module was considered to demonstrate preliminary effectiveness if students' problem-solving skills improved and the average N-gain reached at least the moderate category.

The quality of the developed module was determined based on three criteria. The module was categorized as valid when it met the feasibility criteria based on expert validation. It was categorized as practical when student and teacher responses reached the practical category. It was categorized as preliminarily effective when students' problem-solving skills increased from pretest to post-test based on the N-gain analysis.

Results and Discussion

The first stage of this study was the define stage. This stage identified the need for module development through initial analysis, learner analysis, task analysis, concept analysis, and learning objectives. Interviews with four physics teachers from public senior high schools in South Tangerang showed that students' problem-solving skills were still low. Questionnaire data from 127 students in four public senior high schools supported this finding. Seventy-three percent of students stated that physics was difficult. Sixty-three percent reported that the topic of work and energy was difficult to understand. Sixty-seven percent stated that the textbooks used were not clear or engaging enough. Learner analysis indicated that Grade X students required learning activities that were challenging, collaborative, and supportive of problem solving. Task and concept analyses referred to the revised 2013 curriculum. Although the Merdeka Curriculum has been gradually implemented in Indonesian schools, the revised 2013 Curriculum was used as the instructional design reference in this study because the participating school still applied this curriculum during the research period. The work and energy topic was aligned with Basic Competency 3.9, which corresponds to the core physics concepts also emphasized in the Merdeka Curriculum, particularly the application of work, energy, and conservation principles in solving contextual problems. These indicators covered the concepts of work, the relationship between work, force, and displacement, potential and kinetic energy, and the law of conservation of mechanical energy.

The design stage aimed to produce the initial draft of a module based on problem posing of the post-solution posing type. This stage consisted of four steps: test construction, media selection, format selection, and initial design. Formative tests were developed in the form of essay questions aligned with indicators of problem-solving skills. The selected medium was a printed module, developed using Microsoft Word 2013 and Canva Pro. The module format referred to the revised 2013 Curriculum, guidelines from the Ministry of National Education, and standards from the National Education Standards Board. The output of this stage was Draft I of the module, consisting of an introduction, core content, and closing sections, and ready to proceed to the development stage for expert validation and limited trials.

The third stage was the develop stage. This stage involved two steps: expert validation and product trials. Module validation involved twelve experts, consisting of three learning design experts, three language experts, three media experts, and three subject-matter experts. The validation results for each aspect are presented in Figures 2 to 5.

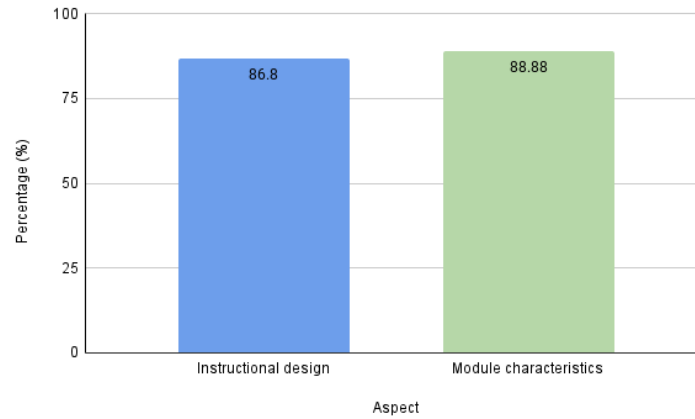


Figure 2. Diagram of instructional design expert validation results

Figure 2 shows the overall assessment by experts on the learning design aspect of the problem-posing-based module. The module was declared valid and feasible for use. The average percentage score from the three experts was 87.85 percent out of a maximum of 100 percent. The highest percentage was 88.88 percent for the module characteristics component. The lowest percentage was 86.80 percent for the instructional design component.

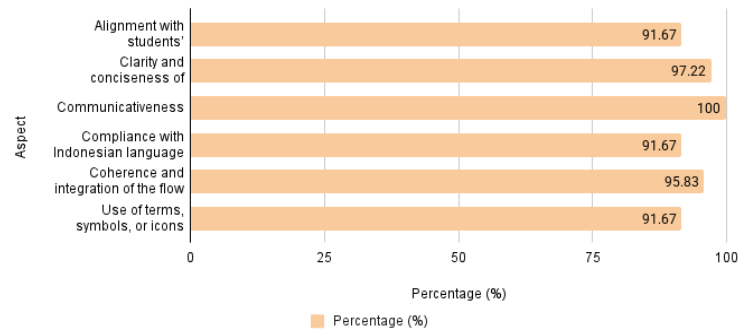


Figure 3. Diagram of language expert validation results

Figure 3 shows the assessment of all language components of the problem-posing-based module. The module obtained a percentage of 95.44 percent out of a maximum of 100 percent. The three experts stated that the module was valid and highly feasible for use. The highest percentage was 100 percent for the communicative component and the use of terms, symbols, or icons. The lowest percentage was 91.67 percent for suitability to students' developmental level, dialogic and interactive quality, and coherence and integration of the flow of thought.

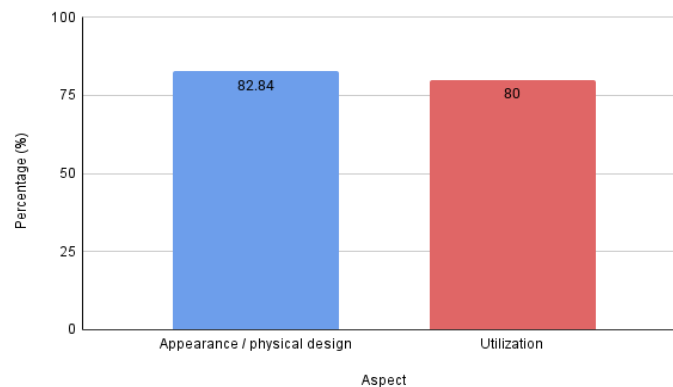


Figure 4. Diagram of media expert validation results

Figure 4 shows the assessment of all components evaluated by media experts. The problem-posing-based module obtained a percentage of 81.42 percent out of a maximum of 100 percent. The three experts stated that the module was valid and feasible for use in teaching work and energy. The highest percentage was 82.84 percent for the appearance or physical layout component. The lowest percentage was 80.00 percent for the utilization component.

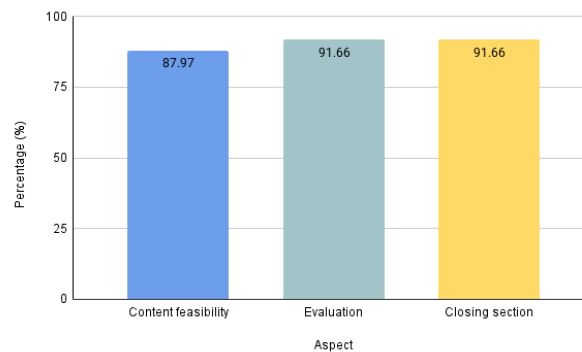
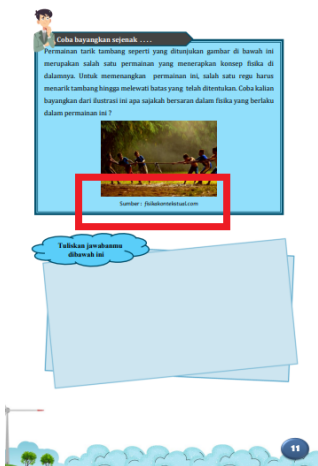


Figure 5. Diagram of subject-matter expert validation results

Figure 5 shows the assessment of all content components evaluated by subject-matter experts. The problem-posing-based module obtained a percentage of 90.37 percent out of a maximum of 100 percent. This result indicates that the product was very good in terms of content. The three subject-matter experts stated that the module was valid and highly feasible for use. The highest percentage was 91.66 percent for the evaluation and closing component. The lowest percentage was 87.79 percent for the content feasibility component. Several revisions made based on expert validation results are presented in Table 1.

Table 1. Revisions to the Problem-Posing-Based Work and Energy Module Based on Subject-Matter Expert Feedback

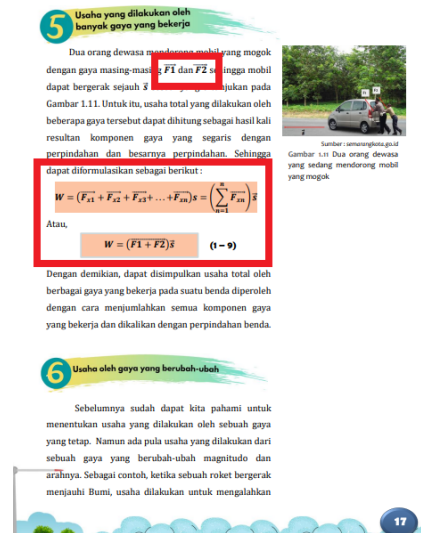
Before Revision	After Revision
Suggestion: Several figures did not include captions and figure numbers. Figures did not include captions and figure numbers. 	 Figures include captions and figure numbers.

Before Revision

Suggestion: Consistency in the use of vector notation for force and displacement. The symbols for “force (F)” and “displacement (s)” were written without arrows indicating vectors.



After Revision



The symbols for “force (F)” and “displacement (s)” are written with arrows indicating vectors.

To evaluate the preliminary effectiveness of the module, improvements in students' problem-solving skills were analyzed for each indicator using N-gain scores. A summary of the results for each indicator is presented in Table 2.

Table 2. N-gain scores by problem-solving skill indicator

Indicator	N-gain	Category
Understanding the problem	0.44	Moderate
Describing the problem in terms of physics concepts	0.50	Moderate
Planning the solution	0.30	Moderate
Applying the solution	0.40	Moderate
Evaluating the solution	0.50	Moderate
Mean	0.43	Moderate

Table 2 shows the N-gain scores for each problem-solving skill indicator. The average N-gain score across all indicators was 0.43. This result indicates that the improvement in students' problem-solving skills on the topic of work and energy was in the medium category.

To assess the practicality of the module from the users' perspective, this study also collected data on student responses through a questionnaire. A summary of student response results is presented in Table 3.

Table 3. Student response data

Component	Average Percentage
Ease of use	82.95
Attractiveness	85.85
Content	83.14
Language	86.92
Mean	84.71

Table 3 shows overall student responses for each indicator related to practicality. The average practicality score was 84.71 percent out of 100 percent. This result indicates that the problem-posing-based module was considered very practical based on student questionnaire responses.

In addition to student responses, module practicality was also evaluated based on teacher assessments to examine its applicability in classroom learning. A summary of teacher response results is presented in Table 4.

Table 4. Teacher Response Data

Component	Average Percentage
Ease of use	91.67
Attractiveness	91.67
Content	95.83
Language	87.50
Mean	91.67

Table 4 shows overall teacher responses for each practicality indicator. The average practicality score was 91.67 percent out of 100 percent. This result indicates that the problem-posing-based module was considered practical based on teacher questionnaire responses.

The results show that the post-solution-posing-based module met the criteria of feasibility and practicality and demonstrated preliminary effectiveness in improving students' problem-solving skills. In terms of feasibility, all validation components were in the high range. The language aspect obtained the highest score, at 95.44 percent. This result indicates that instructions, terminology, and message presentation were clear for users. Language clarity is critical in a problem-posing approach because students must independently construct questions and interpret problem contexts.

The trial phase to measure the preliminary effectiveness of students' problem-solving skills involved 43 Grade X students, with a pre-test and post-test consisting of five descriptive test instruments that had been validated by two material experts. The improvement of students' problem-solving skills can be seen based on the N-gain calculation table, which produces an average score for all problem-solving skill indicators of 0.43, with a moderate category. The problem-solving skill indicators that were improved in this study were understanding the problem, describing the problem in physics concepts, planning solutions, implementing solutions, and evaluating solutions.

The smallest improvement was found in the planning-the-solution indicator, with an N-gain score of 0.30 in the moderate category. This result indicates that students still experienced difficulties in selecting appropriate formulas and determining solution steps based on the problem situations presented. One possible reason is that work and energy problems require prerequisite understanding of force and Newton's laws of motion, whereas students had not fully studied these concepts during the trial. This finding is consistent with Pratama et al. (2017), who reported that students experienced difficulties in solving problems related to work and energy. In the solution-planning stage, students are expected to determine the steps, concepts, or equations needed to solve a problem (Lestari et al., 2019). Therefore, this stage requires stronger scaffolding because students must connect conceptual understanding with an appropriate mathematical strategy.

Meanwhile, the highest improvement was found in describing the problem in terms of physics concepts, with an N-gain score of 0.50 in the moderate category. This result shows that the module helped students identify known variables, target variables, and relevant physics concepts in a problem. The improvement can be explained by the post-solution posing activities embedded in the module, in which students analyzed solved problems, identified conceptual and mathematical structures, modified problem conditions, constructed new problems, solved the generated problems, and evaluated the consistency of their solutions. These activities supported problem-solving skills by guiding students to understand the problem, represent it using physics concepts, plan and apply solution strategies, and evaluate the outcomes. Thus, the module demonstrated preliminary effectiveness in improving students' problem-solving skills from pretest

to post-test, particularly in supporting conceptual representation, although further refinement is needed to strengthen students' ability to plan solution strategies.

The trial phase to measure the practicality of the problem-posing-based module involved 43 students and 3 teachers. The practicality results showed that the problem-posing-based module was very practical for classroom use. Student responses for the practicality aspect obtained a percentage of 84.71% in the very practical category. The results of the teacher response questionnaire for the practical aspect obtained a percentage of 91.67% in the very practical category. The module was categorized as very practical because students and teachers perceived the module as easy to use, clear, attractive, and relevant to classroom learning.

The implications of this study are directly applicable to physics teaching practice. Teachers can use the module as a structured instructional tool to train problem-solving skills step by step, from understanding problems to evaluating solutions (Asih et al., 2022; Suryadi et al., 2023). The module can also serve as a reference for designing student worksheets or formative assessments based on problem posing. For schools, these results support the integration of instructional materials that promote higher-order thinking skills in the topic of work and energy. For development researchers, the findings provide evidence that strengthening language components and activity design can improve module implementation in real classroom settings.

This study has several limitations. The preliminary effectiveness measurement relied mainly on N-gain scores without analysis of long-term effects on concept retention. The content scope was limited to work and energy, so generalization to other physics topics requires caution. The number of validators and the trial context were limited to specific settings, so variations in school characteristics were not fully represented. In addition, the planning-a-solution indicator did not improve optimally, indicating that learning support design at the strategy stage requires further refinement in future development.

Overall, the problem-posing-based module is ready for use in teaching work and energy. The next development priority focuses on improving media utilization and strengthening the planning-a-solution stage to increase the impact on problem-solving skills in future implementations.

Conclusion

This research produces a physics module based on the Problem Posing type Post Solution Posing on the material of work and energy for class X that meets the criteria for quality learning products. The validation results show that the module is in the valid to very feasible category in the aspects of learning design, language, media, and materials. The results of the practicality test show that the module is very practical based on student and teacher responses. The results of the preliminary effectiveness test show an increase in students' problem-solving skills with an average N-gain of 0.43 in the moderate category. Thus, this module can be used as an alternative teaching material to support physics learning that is more directed at developing problem-solving skills.

Although the module has demonstrated satisfactory feasibility, practicality, and preliminary effectiveness, several opportunities for further improvement remain. Future studies may extend the implementation to a wider range of schools and student characteristics to enhance the generalizability of the findings. Longitudinal studies are also recommended to examine the impact of the module on long-term concept retention and the development of problem-solving skills over time. In addition, future development may focus on strengthening scaffolding at the solution-planning stage, which showed the lowest improvement among problem-solving indicators. From a practical perspective, the results of this study suggest that integrating problem-posing activities into physics modules has strong potential to promote active learning and deeper conceptual engagement. Reflecting on the development process, this study highlights the importance of aligning instructional design, language clarity, and learning activities to effectively support students in constructing and solving physics problems.

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