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Problem Based Learning Modules in Environmental Education to Improve Problem Solving Ability

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Abstract

Problem solving is the ability of groups and individuals to find a solution to a problem. It is necessary to have problem-solving skills to face the challenges of the 21st century. Problem-solving abilities can be improved using the problem-based learning model. The use of the environment as a learning resource makes learning more meaningful. So it is necessary to develop teaching modules based on problem-based learning integrated with environmental education to improve problem-solving skills. This study aims to analyze the results of the validity of teaching modules based on problem-based learning integrated with environmental education to improve problem-solving skills on climate change material. The method used in this study is the R&D method with the ADDIE development model. In this study, there were three stages used, namely the analysis stage, namely determining the needs of students regarding the teaching modules on climate change material, the design stage, namely planning the teaching modules to be developed, and the development stage, namely compiling and validating. The validity of the teaching module is assessed based on the feasibility of the content, language and presentation which consists of nine indicators. The analysis technique was carried out by calculating the results of the teaching module validity of the 4 validators. The advantages of this teaching module are that it uses the PBL learning model, integrates environmental education, trains indicators of problem-solving abilities. The drawback is that the teaching modules are not yet digital based. The main suggestion from the validator is to make the cover page more attractive and characterize the author's character and the trigger questions included at the problem orientation stage can be broader (not short). The results showed that the average validity value of the three validators in problem-based learning integrated teaching modules integrated with environmental education to improve problem-solving skills on climate change material developed had very valid validity results. This is in accordance with the overall average value of validity and reliability obtained by 96.53% and 93.65%. So it can be concluded that the teaching modules developed are feasible to be applied in the learning process. The implication of this research is to have a positive impact on students regarding the use of environmental education (environment as a learning resource) in physics learning so that it can be used as a solution to improve students' problem-solving abilities.

Keywords: Teaching Module, Validity, PBL Model, Environmental Education, Problem Solving Ability.

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INTRODUCTION

The 21st century, especially the era of *society 5.0,* demands changes to the education system in Indonesia. Education in the era *of society 5.0* requires human resources who have certain competencies such as problem-solving skills, innovation skills, critical thinking skills, high comprehension skills, life and career skills, collaboration, and communication skills, as well as the ability to master information and communication technology media (Abidah et al., 2022). One of the competencies that must be possessed to create a superior generation to face the demands of the 21st century is the ability to solve problems (Kurniawati et al., 2019). Problem solving ability is an individual's ability to find solutions or solutions to the problems being faced with the right steps using the knowledge and understanding they already have. (Akuba et al., 2020). The ability to solve important problems is owned as an effort by students to use skills and knowledge from the learning process that is carried out to be applied to everyday life, so that they can solve the problems they face (Setiawan et al., 2021).

Problem solving ability is a priority in learning so it needs to be improved. This is in line with the results of research which states that the ability to solve problems is an educational priority in terms of curriculum as something that must be owned and mastered by students to support their understanding in learning (Novianti & Fakhriyana, 2022). Problem solving ability has several indicators. According to Lestari (2017) the ability to solve problems has 6 indicators, namely showing the phenomena that exist in the problem and summarizing them in the formulation of the problem, formulating in the form of questions that give directions to obtain answers, analyzing each data obtained and its suitability with the problem under study, planning problem solving and showing reasons, evaluating based on facts, principles or guidelines for solving alternative solutions quickly and precisely, concluding solutions to problems that have been analyzed.

Improving problem-solving abilities as an effort to deal with the demands of the 21st century can be implemented if the applied curriculum supports student-centered learning. Independent curriculum adopting the concept of independent learning which is in line with the philosophy of progressivism which provides opportunities to develop knowledge, potential, interests and talents through learner-centered learning, so that students' problem-solving abilities can increase (Meliniasari et al., 2023). One of the objectives of the independent curriculum is science as axiology, namely how the implementation of knowledge can be used to find solutions to problems (Trisnawati et al., 2022). The independent curriculum is refinement of K13 to deal with progress in the field of education that corresponds to modern times with aim to support learner-centered learning as well as freeing students to express themselves so that their abilities can grow and develop (Anwar et al., 2022). The curriculum in 21st century learning will be carried out well if it is supported by the implementation of appropriate learning models and according to needs (Sahil et al., 2022).

Student-centered learning models to deal with the demands of the 21st century include discovery learning, project based learning, cooperative learning, collaborative learning, contextual instruction, problem based instruction, and problem based learning. The advantages of the problem model based learning Student-centered learning, provides opportunities for students to investigate and study multidimensional events with a deeper perspective, improves students' problem-solving skills, and encourages students to learn new material and concepts when solving problems (Zainal, 2022). Problem based learning is learning that applies real problems as a learning resource for students to train critical thinking and gain skills in problem solving, as well as acquiring knowledge as well as important concepts from the material studied (Susanto, 2020). In addition to using learning models that suit needs, 21st century learning needs to pay attention to aspects of environmental sustainability.

Environmental aspect is one of the important factors in improving learning in the 21st century as an effort to instill awareness of its importance maintaining the existing environment and emphasizing the process of forming a life that is in harmony between humans and the natural surroundings (Nurhikmah & Hasanah, 2021). This can be done by integrating the environmental education approach into the learning model used. Environmental Education is a pioneer in encouraging solving is done problem solving, critical thinking, and interdisciplinary education, as well as other integral components in the educational change movement (Suwondo *et al.*, 2019). The integration of environmental education into the learning stage functions to train students to maintain and maintain a protective attitude environment in the best possible way (Yanti & Yusliani, 2020). Environmental education in the 21st century requires students to develop their thinking skills to be able to anticipate changes in the environment that are happening at this time (Komala *et al.*, 2020).

One of the natural phenomena as a result of environmental changes and also human activities that are currently being faced is climate change. Climate change is a long - term change in weather patterns that occurs on a global scale (Siringoringo, 2022). Climate change is a phenomenon that all people need to pay attention to. Knowledge and skills need to be owned by the community in supporting environmental conservation efforts to deal with climate change (Alam *et al.*, 2022). Physics as a natural science that physically examines and studies various events that occur in the surrounding environment (Nova *et al.*, 2021). Environmental education integrated physics material related to climate change that is studied in schools, namely global warming. Warmup Global warming is a phenomenon of increasing average land temperature earth, atmosphere, as well as the sea. Warmup global l is wrong an environmental phenomenon main ones faced by the world community (Wildan *et al.*, 2019).

Physics learning can be started by motivating students to be more sensitive to the surrounding environment. This can be done with the support of the teaching modules used. Teaching modules are learning designs that are based on the applied curriculum with the aim of achieving predetermined competency standards and have a major role to support teachers in designing learning (Maulida, 2022). Learning is carried out well if it is carried out in accordance with the teaching modules used. This is consistent with the results of research which states that the implementation of learning is good if the application is appropriate and systematic with the scenarios designed (Andelinawati et al., 2022).

Based on this explanation, it is necessary to innovate teaching modules that can support student-centered learning and improve problem-solving skills. Therefore, this research was conducted to develop teaching modules based on *problem-based learning* integrated with environmental education related to climate change in global warming material to improve students' problem-solving skills.

METHOD

This research is a development research using the *Research & Development* (R & D) method with the ADDIE model. R&D is a research method used to produce a particular product, and test the effectiveness of the product the (Sugiyono, 2019). The product resulting from this research is a *problem based learning* integrated teaching module based on environmental education on climate change material. The ADDIE model in question consists of 5 stages, namely *Analyze, Design, Development, Implementation, and Evaluation.* The stages of the ADDIE model are presented in Figure 1.

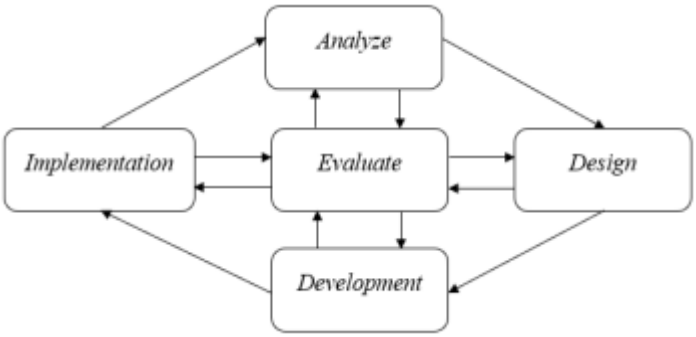

Figure 1. Stages of the ADDIE Model
(Sugiyono, 2019)

The limitation of this research is that the use of the ADDIE model only reaches the "*Development" stage*. This is because the purpose of this research is to determine the validity of the teaching modules developed. So that it does not reach the trial stage to measure the effectiveness and evaluation of the developed teaching modules. So that the stages carried out are analysis *(analyze)*, design *(design)*, and development *(development)*. The analysis phase is carried out by analyzing the needs related to the required teaching modules and material on the topic of climate change. At the design stage the authors designed the design and content of the teaching modules to be developed. At the development stage the authors compiled teaching modules, validation, and revision after validation of *problem based learning* integrated teaching modules on environmental education on climate change material.

The data analysis technique was carried out by analyzing the results of teaching module validation by the validator using a *Likert scale* , namely a score of 4 (very good), a score of 3 (good), a score of 2 (fairly good), and a score of 1 (not good). The score will be calculated, analyzed, and categorized based on Table 1.

Table 1. Criteria for the Level of Product Validity

Criteria	Category	Information
85.01 % - 100 %	Very Valid	Can be used without revision
70.01 % - 85 %	Adequate	Usable but needs a little revision.
50.01 % - 70 %	Less Valid	Usable but needs a lot of revision.
01.00 % - 50 %	Invalid	Cannot be used

(Zetriuslita et al., 2022)

The validity of the teaching module is calculated using equation (1)

$$Validity = \frac{total\ \ validity\ score}{maximum\ total\ score}\ X\ 100\% \quad (1)$$

(Yudiafarani et al., 2022)

The reliability of the teaching modules developed in the research was analyzed using the PA *(Percentage Agreement)* method with equation (2):

$$PA = \left(1 - \frac{A-B}{A+B}\right)\ 100\% \quad (2)$$

(Pratiwi et al., 2021)

With A being the highest score of the validator and B being the lowest score of the validator. The instrument is said to be reliable if the percentage agreement value is more or equal to 75%.

RESULTS AND DISCUSSION

Development of teaching-based modules problem based learning integrated environmental education based on existence the problem is that the module is not yet available devoted to improving students' problem-solving abilities. Likert scale and calculated using the product validity equation and PA *(Percentage Agreement).* The product resulting from the research that has been carried out is a problem-based learning-based teaching module integrated with environmental education to improve problem-solving skills. The resulting product is developed through three stages, namely analysis, design, and development

Analyze

The analysis phase is carried out to find out the teaching modules on climate change material needed by students. The analysis phase was carried out through observation and interviews with one of the physics teachers at SMA and as part of the preliminary study. The questions asked during the interview included the material being taught, the use of problem-based learning models, and students' problem-solving abilities. The results of observations and interviews show that students have difficulty learning climate change material. The reason is that learning is only done in the classroom, learning focuses on theory, climate change material is only taught briefly (not in depth). The emergence of boredom and laziness as well as the difficulties of students learning climate change material due to the lack of teacher innovation and creativity in learning. This is in line with the results of research which states that saturation and laziness of students to take part in learning properly and listen to the teacher's explanation because lack of creativity and innovation provided by teachers in learning (Agusty, 2020).

To overcome these difficulties, an appropriate learning model is needed. The learning model that can be used is a problem-based learning model (PBL). The PBL model is a learner-centered learning model that begins with real problem orientation activities that are around and ends with finding solutions to solving these problems. Based on interviews and observations made, the PBL model is suggested to be used in physics learning because it is suitable for improving students' problem solving abilities which are still low. This is consistent with the results of research which states that the problem-based learning model *is a* learning model that is suitable for use in solving problems because it emphasizes giving direct experience to students in solving physics problems , so that it can improve students' problem-solving abilities (Aripin et al., 2021).

Problem solving ability is very important in learning physics. This is in line with the results of research which states that learning physics requires qualified problem solving abilities as a basis for students. To understand problems in physics as well as a reference for solving problems in physics learning (Hindriyani et al., 2020). One of the efforts to improve students' problem-solving abilities is by integrating environmental education in the learning that is carried out. This is in line with the results of research which states that environmental education is a learning approach that focuses on the activeness of students by using the environment as an optimized learning resource to improve problem-solving skills and quality educational outcomes by paying attention to the elements applied (Dayanti, 2018).

Based on this needs analysis, the specifications for teaching modules that need to be developed are (1) teaching modules that use the PBL model, (2) teaching modules integrated with environmental education, (3) teaching modules that train indicators of problem solving ability. The teaching modules developed are expected to be able to support student-centered learning and be able to improve problem-solving abilities. As well as being part of innovation in the implementation of learning activities.

Design

The design stage is carried out by designing teaching modules that suit the needs of students. There are 3 specifications of the teaching module developed, namely:

1. Problem Based Learning (PBL) Model

   The teaching modules developed are adapted to the learning stages of the PBL model. According to Arends (2012) PBL has five stages, namely (1) Problem orientation, (2) Organizing students for learning, (3) Guiding both group and independent investigations, (4) Developing and presenting work, (5) Analyzing and evaluating the process and results of problem solving. The linkage of teaching modules with PBL syntax is presented in Table 2.

Table 2. Linkages of Teaching Modules with PBL Syntax

Stages	Contents of the Teaching Module
Orientation of students to the problem	The teacher explains the learning objectives, explains the logistics needed, proposes phenomena or demonstrations or stories to raise problems and motivates students to engage in selected problem-solving activities.
Organizing students to learn	Teachers help students to define and organize learning tasks related to these problems.
Guiding group/independent investigations	The teacher encourages students to collect appropriate information carrying out investigations to get explanations and problem solving.
Develop and present the work	The teacher helps students by planning and preparing suitable works such as posters and helping them to share assignments with their friends.
Analyze and evaluate the problem solving process	Teachers help students to reflect or evaluate their investigations and the processes they use.

2. Environmental Education

   According to UNESCO in Supadmini *et al.,* (2020). Environmental education consists of three concepts, namely:

   a. Education about the environment has the goal of developing understanding and knowledge of students about the physical, social and natural systems that build the environment.
   b. Education for the environment (education in environment) aims to develop students' attitudes to work to improve the environment, care for the environment, and foster positive values and attitudes towards the environment.
   c. Environmental education (education for environment) is the stage of education to make the environment a learning resource. Resources that can develop large amounts of insight as well as develop skills in communicating and investigating.

The concept of environmental education used in the teaching modules is education for the environment which is integrated at the problem orientation stage. The use of the environment as a learning resource must also pay attention to the elements of environmental education, namely empirical, caring, aesthetic, and social elements (Dayanti, 2018). However, in this study the elements applied are empirical elements by providing as many opportunities as possible for students to interact with their environment directly. The second element, namely caring is applied by providing an understanding that is able to raise awareness that the environment is a complex thing.

3. Train problem solving indicators

The indicators used in this study are indicators of problem solving ability according to Lestari (2017). There are 6 indicators used as presented in Table 3. The problem-solving ability indicators in Table 3 need to be integrated with an environmental education approach which is then trained at each stage of learning using the PBL model. Based on the specifications described above, all of them are merged into one so that the final design of problem-based learning integrated teaching modules is obtained, integrated with environmental education to improve problem-solving skills on climate change material, as shown in Table 4.

Table 3. Indicators of Problem Solving Ability

Problem Solving Stage	**Indikator**
Identification of problems	Shows the phenomena that exist in the problem and summarizes it in the problem formulation .
Formulate Problems	Formulate in the form of questions that give direction to obtain answers .
Analyze Problems	Analyze each data obtained and its suitability with the problem under study .
Looking for Solutions	Plan problem solving and show reasons .
Do Evaluation	Evaluate based on facts, principles or guidelines for completing alternative solutions quickly and precisely .
Draw a conclusion	Summarize the solution of the problems that have been analyzed .

Table 4. Relationship Between Problem Based Learning Models and Environmental Education Integrated Problem Solving Ability Indicators

***Problem-based learning* steps**	**Problem Solving Ability Indicator integrated environmental education**
Orientation of students to the problem	• M show phenomena that exist in environmental problems related to global warming and summarize them in the problem formulation. • Formulate environmental problems related to global warming in the form of questions that give directions to obtain answer. (environmental problems as a source of learning)
Organizing students to learn	• Analyze each data obtained and its suitability related to the global warming problem studied.
Guiding group/independent investigations	• Planning to solve environmental problems related to the effects and factors of global warming and put forward the reasons.
Develop and present the work	• Evaluate based on facts, principles or guidelines for solving alternative solutions to environmental problems related to efforts to tackle global warming appropriately.
Analyze and evaluate the problem solving process	• Summarize efforts to reduce global warming related to changes in personal behavior.

An example of the implementation of the relationship between *the problem-based learning* model and the indicators of integrated problem-solving ability in environmental education in the developed teaching modules is presented in Figure 2.

Fase 1 **Mengorientasikan peserta didik pada masalah.**	✓ Guru memaparkan suatu permasalahan yaitu, "Negara kita Indonesia, merupakan negara tropis yang memiliki 2 musim yaitu musim hujan dan musim kemarau. Tetapi dari berita yang sering ditayangkan di	✓ Peserta didik bersama dengan kelompoknya mencermati permasalahan yang dipaparkan oleh guru. **(Indikator menunjukkan fenomena yang ada dalam permasalahan lingkungan terkait pemanasan global dan merangkumnya dalam rumusan masalah)**

Figure 2. The Problem Orientation Stage is Trained in The Ability to Identify Problems

The uniqueness of the teaching modules developed based on problem-based learning integrated with environmental education to improve problem-solving skills is that indicators of problem-solving abilities are trained at each stage of the problem-based learning model through an environmental education approach (environment as a learning resource). This aims to maximize the improvement of problem-solving abilities through the application of the developed teaching modules.

Stage Development

The teaching module is validated by 4 validators consisting of four expert lecturers in the field of innovative learning. After getting suggestions and input from the validator, the researcher will make revisions according to the suggestions and input received. There are several suggestions from the validator, namely making the cover page more attractive and characterizing the author's character and starting questions included at the problem orientation stage can be broader (not short). The revision results are as described in Figure 3, Figure 4, Figure 5, and Figure 6.

Based on Table 5, it is known that the aspects assessed include the feasibility of content, language, and presentation which consists of nine indicators. The first indicator is the identity of the subject that gets a validity and reliability value of 100% (very valid). This is in accordance with the results of research which states that the indicator subject identity gets a very valid category, which means it can be interpreted that the item has a high coefficient (Wulandari & Oktaviani, 2021). The second indicator, namely the formulation of objectives/indicators, obtains a validity and reliability value of 100%. The formulation of objectives/indicators in the teaching module must be in accordance with the learning outcomes and learning objectives carried out, and include the problem solving skills being trained. This is consistent with the results of research which states that before designing teaching modules, first determine learning outcomes and translate them into learning objectives and indicators of achievement of aligned learning (Hariani et al., 2023).

Figure 3. Cover Page Before Revision

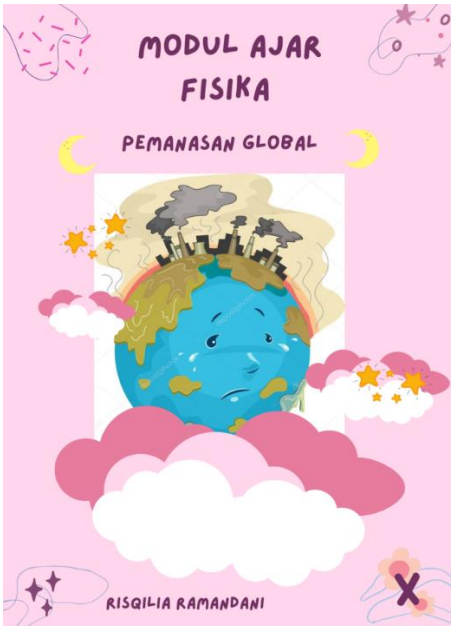

Figure 4. Cover Page After Revision

Inti	Fase 1 **Mengorientasikan peserta didik pada masalah.**	✓ Guru memaparkan suatu permasalahan yaitu, Mengapa suhu bumi terasa semakin panas pada saat ini?".

Figure 5. Trigger Questions Before Revision

Inti	Fase 1 **Mengorientasikan peserta didik pada masalah.**	✓ Guru memaparkan suatu permasalahan yaitu, "Negara kita Indonesia, merupakan negara tropis yang memiliki 2 musim yaitu musim hujan dan musim kemarau. Tetapi dari berita yang sering ditayangkan di televisi musim hujan dan musim kemarau yang terjadi di Indpnesia sudah tidak teratur. Kadang di bulan-bulan yang seharusnya terjadi musim hujan malah musim kemarau yang terjadi, sebaliknya di bulan-bulan yang seharusnya musim hujan, tetapi Indonesia malah di landa musim kemarau yang berkepanjangan. Ada apa dengan Bumi kita?".

Figure 6. Trigger Questions After Revision

The third indicator is material which obtains a validity of 93.75% and a reliability of 85.71%. The material presented must be in accordance with the learning objectives, the cognitive level of students, and coherently. This is in line with the results of research which state that the material in teaching modules must be presented in a coherent and systematic manner to be used as a reference in teaching and learning activities. so participants students are able to master all competencies and objective learning with maximum learning in accordance level of cognitive development participant educate (Revelation, 2022). The fourth indicator is the learning method which yields a validity of 93.75% and a reliability of 85.71%. The learning method used must be in accordance with the learning objectives, the material being taught, and support the improvement of problem solving abilities. This is in line with the results of research which states that a teacher must choose method learning according to the needs of students who used for support successful

achievement of learning objectives in accordance with the the material being taught as well as support for improve ability student problem solving (Aziz et al., 2020). The method used in the teaching module used is the demonstration method. This is consistent with the results of research which states that the PBL model with the demonstration method is an approach in learning that helps students to find problems from a real event. (Suardana, 2019).

Table 5. The results of the validity and reliability of teaching modules

Teaching Module Indicator	Total Score	validity		Reliability	
		Score	Category	Alpha	Category
Subject Identity	16	100	very valid	100	Reliable
Formulation of Objectives/Indicators	16	100	very valid	100	Reliable
Material	15	93.75	very valid	85.71	Reliable
Learning methods	15	93.75	very valid	85.71	Reliable
Learning Activities	16	100	very valid	100	Reliable
Selection of Media / Learning Resources	15	93.75	quite valid	85.71	Reliable
Assessment of Learning Outcomes	14	87.5	very valid	85.71	Reliable
language	16	100	very valid	100	Reliable
Character development	16	100	very valid	100	Reliable

The fifth indicator is learning activities that obtain validity and reliability results of 100%. Learning activities must be carried out in a coherent manner and in accordance with the allocation of learning time, as well as support for practicing problem-solving skills. The learning activities applied to the developed teaching modules are adapted to the syntax of the PBL model. This is in line with the results of research which states that the PBL model takes place naturally in the form of student activities to increase student independence and strengthen problem - solving abilities in various contexts (Saputro & Rahayu, 2020). The sixth indicator is the selection of media/learning resources which results in a validity of 93.75% and a reliability of 85.71%. The learning media/resources used must be in accordance with the learning objectives, cognitive development of students as well as being practical and easy to use. This is in line with the results of research which states that the learning resources used must be in accordance with the learning objectives and cognitive development of students, easy to use as an alternative to efficient and effective learning , and use language that is simple and easy to understand. (Azkiya et al., 2022). Teaching modules developed use the environment as a source of learning (environmental education) to improve students' problem-solving abilities. This is also in accordance with the results of research which states that by providing an environment as a realistic learning resource it is proven to increase students' problem solving abilities (Zuhri et al., 2022).

The seventh indicator is the assessment of learning outcomes which obtains a validity of 87.5% and a reliability of 85.71%. Assessment of learning outcomes that must be in accordance with learning objectives, there are work instructions, and answer keys are available. This is in line with the results of the study which stated that the assessment instrument must pay attention to its suitability with learning objectives, provide a key answer and instructions processing using language that is easy to understand and able to measure the abilities being trained (Sari et al., 2023). The eighth indicator is language which obtains 100% validity and reliability. The language in the teaching module must be in accordance with the rules of the Indonesian language which are good, clear and easy to understand. This is in line with the results of the study which

stated that the making of teaching modules must pay attention to the rules Language Indonesia good and correct (PUEBI) and use sentences that are easy to understand and understand (Handayani et al., 2021).

The last indicator is character development which obtains 100% validity and reliability. Character development in teaching modules must be in accordance with the abilities and characters being trained. The skills and characters that are trained are problem-solving skills and caring for the environment. This is done by training each indicator of problem-solving ability at each stage of the integrated *problem-based learning model* of environmental education (environment as a source of learning). This is in line with the results of the study which stated that the advantages of applying a series of stages Problem-based learning that is adapted to indicators of problem-solving abilities can improve students' problem-solving abilities (Nababan, 2019).

The advantages of teaching modules based on problem-based learning integrated with environmental education are that they provide opportunities for students to measure their understanding of the problems identified , to be able to develop their potential to the fullest according to their level of ability and speed in finding solutions to the problems they face, and to provide opportunities for various ways of learning, so that individual differences and uniqueness when learning can be well served. This is in line with the results of research which states that PBL-based teaching modules can increase the enthusiasm of students in learning , make it easier for students to measure their understanding of the material they receive, and support learning outcomes so that they are more optimal in terms of quality and quantity. (Sari, et al., 2021). The drawback of the developed teaching modules is that they are not yet available in digital form.

Based on the results of this analysis, it can be seen that the average validity of the teaching module by the four validators is 96.53% (very good). In addition, based on the nine indicators it can also be seen that the average reliability of teaching modules by four expert lecturers is 93.65% (reliable). The results of the study show that the developed teaching modules are feasible to use.

CONCLUSION

Based on this explanation, it can be concluded that the teaching module based on *problem-based learning* integrated with environmental education to improve problem-solving skills in the developed climate change material has very valid validity results. This is in accordance with the overall average value of validity and reliability is categorized as very valid. It can be concluded that the teaching modules developed are feasible to be applied in the learning process. Further research can be explored by conducting trials of teaching modules based on *problem-based learning* integrated with environmental education to determine practicality when applied in learning. Also, analyzing the effect of *problem-based learning* integrated teaching modules on environmental education to improve problem-solving abilities. The implication of this research is to have a positive impact on students regarding the use of environmental education (environment as a learning resource) in physics learning so that it can be used as a solution to improve students' problem-solving abilities.

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