

## ICARE-BASED PHYSICS E-MODULE DEVELOPMENT TO ENHANCE PROBLEM SOLVING AND COMMUNICATION ON PRESSURE CONCEPTS

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**Abstract:** This study aims to develop an ICARE-based physics e-module (Introduction, Connecting, Application, Reflection, Extension) that is effective in enhancing students' problem-solving and communication skills. The research utilized a Research and Development (R&D) approach, following the ADDIE development model. The population and sample consisted of all students from class VIII B at SMPN 4 Tanantovea. Data collection methods included the validation of the e-module by two expert validators, student questionnaires, essay tests administered twice before (pre-test) and after (post-test) the learning process to assess problem-solving skills, and observation sheets used across three sessions to evaluate students' communication skills. The data were analyzed descriptively using statistical tools. The results indicated that the e-module was rated as highly feasible, with a validation score of 93%. Its effectiveness in improving students' problem-solving skills was categorized as very high, with a Cohen's d effect size of 7.126. In terms of communication skills, the average student score after using the ICARE-based physics e-module was 26.45 (47%) in the first session, 32.1 (57%) in the second session, and 44.6 (80%) in the third session. Based on these results, the ICARE-based physics e-module is considered highly suitable for use in classroom learning.

**Keywords:** Communication skills, E-module, ICARE, Problem solving skills

### 1. INTRODUCTION

Education plays a crucial role in the development of science and technology. The rapid advancement of scientific knowledge is marked by the emergence of new technologies that facilitate human activities, including in the field of education (Lestari, 2018). The dynamic changes occurring within the educational landscape require both teachers and students to develop the ability to address unpredictable challenges. The advancement of science and technology in various aspects of life has led to increased demands for the competencies of today's younger generation. Education is expected to produce individuals who are faithful, productive, creative, innovative, and possess strong affective qualities (Rahmawati et al., 2022)

The progress of a nation is influenced by the quality of its education, as a high level of education can produce a qualified human workforce (Walid, 2017). The learning process plays a vital role in supporting students' learning outcomes and objectives, making the quality of the learning process a critical concern. A well-developed human resource is characterized by the possession of essential skills required in this era, which is driven by digitalization and

globalization. These developments are a result of the rapid advancement in science and technology, thus necessitating skills such as communication, collaboration, creativity, complex problem-solving, and critical thinking collectively known as 21st-century skills (Zubaidah, 2019). There are many factors that can influence the quality of the learning process, both internally and externally, one of which is the use of interactive learning media (Tafonao, 2018)

Science (IPA) is a subject that is essential for students to master, particularly in the area of Physics. Physics is considered one of the most fundamental branches of science, serving as the foundation for all other scientific fields. As a component of the science curriculum, physics often demands relatively high intellectual ability, which leads many students to experience difficulties in understanding the material.

Brousseau, as cited in Hartono (2019), stated that the identification of epistemological obstacles in learning can be carried out through the analysis of historical methods. This approach involves the use of carefully designed questions aimed at evaluating students' understanding of previously acquired knowledge. Through these questions, it is possible to analyze how students interpret and comprehend the usefulness of a concept, explain the benefits of applying acquired knowledge, and connect the concept with other relevant concepts. Furthermore, this analysis enables educators to observe students' ability to identify problems, provide justification for proposed solutions, and recognize recurring response patterns to identical or potentially misconception-inducing questions. Understanding how students respond to and interpret each question serves as an important indicator in revealing epistemological obstacles that hinder the process of knowledge construction.

In lessons related to the concept of the effect of pressure on the volume of liquids, students have not yet been able to operate symbols within equations or calculations, which leads to difficulties in solving problems. Students struggle to understand formulas and their derivations, have difficulty interpreting and reading graphs and diagrams, and face challenges in performing the necessary calculations to solve learning tasks. These difficulties may arise due to students' lack of conceptual understanding, insufficient preparation for learning, and limited ability to apply mathematical operations. As a result, students encounter obstacles in problem-solving, indicating a lack of adequate problem-solving skills.

Ani et al, (2017) state that one of the factors influencing students' low problem-solving and communication skills is the learning strategies implemented by teachers during classroom instruction, such as the models, methods, and media used in the learning activities. In line with this, problem-solving skills are essential abilities that need to be developed in students to

prepare them for competing with the challenges of the 21st century (Kurniawati et al., 2019). Another important skill to develop in students is communication. However, field observations indicate that students' problem-solving and communication skills remain low. Furthermore, it was found that the school has not yet developed or implemented the use of e-modules in the learning process, as teachers have not been able to create electronic-based modules integrated with learning models, such as ICARE-based e-modules.

Based on the researcher's observations, it was found that the school was already equipped with internet/Wi-Fi. However, some teachers, particularly the science teacher, also provided a dedicated internet facility (Orbit) to anticipate any Wi-Fi network issues. Students were also permitted to use their mobile phones to search for materials online during the learning process. Therefore, the researcher was interested in developing interactive learning media.

The use of interactive learning media can take the form of technology-based modules containing images, various texts, sounds, animations, and even videos, thus helping to improve science literacy. E-modules are also electronic versions of modules, where access and use are carried out through electronic devices such as computers, laptops, tablets, or even smartphones (Nopiani et al., 2021). The use of electronic modules in the classroom learning process can have a positive impact on students, because they are easily accessible, allowing students to learn independently. Success in the 21st century in the digital era depends heavily on students' skills, including critical thinking, problem-solving, communication, and collaboration. Modules are used to facilitate students' understanding of the material presented independently or through the guidance of educators with interesting module content (Hamid & Alberida, 2021). The use of this e-module is very suitable for application in physics subjects, because most of the material in physics is abstract and contextual, as stated by BSNP that in physics learning students will be introduced to materials, concepts, principles, theories, principles, and laws of nature, for example in the material on pressure.

ICARE-based modules are teaching materials that combine active, process-oriented learning methods, direct students to be more independent and reflective, and strive to provide learning experiences to students (Yani, 2018). ICARE-based e-modules are used as teaching materials that can be utilized by students as learning materials at school, which aims to make learning fun and interesting for students. Students are also expected to be able to learn independently without feeling forced, and students can focus their attention enthusiastically in participating in learning. So, it can be concluded that ICARE-based learning modules are modules in which teachers allow students to apply/apply what they have learned in the teaching

and learning process. By implementing the ICARE learning model, students are directed to actively construct and relate their knowledge so that they understand the material (Sri Jayanti et al., 2019). To make modules more engaging, innovation is needed in module development, namely ICARE-based modules (introduction, connecting, application, reflection, extension). ICARE stands for Introduction, Connect, Apply, Reflect, and Extend. ICARE learning is characterized by active, creative, and joyful learning. ICARE is a learning model that connects the material and applications taught to students to deepen their understanding of the material, starting from introduction, connecting, applying, reflecting, and evaluating (Mawarni & Sinuraya, 2022).

The National Council of Teachers of Mathematics (NCTM) highlights the importance of students meeting five standards when learning mathematics (Hasugian et al., 2024). Ensuring proficiency in the following areas is a prerequisite for mathematics education: (1) the ability to reason and provide logical justification (reasoning and proof); (2) the ability to solve problems effectively (problem solving); (3) the ability to articulate mathematical ideas (communication); (4) the ability to establish relationships between different mathematical concepts (connections); and (5) the competence to represent mathematical ideas in various forms (representation). Proficiency in mathematical problem solving and communication is an important skill for students.

Problem-solving skills are expected learning outcomes. Students can gain experience by utilizing their existing knowledge. Problem-solving skills are the ability to find solutions through a process involving the acquisition and organization of information (Azizah et al., 2017). Problem-solving skills are essentially the essence of learning objectives, essential for students to solve problems related to their field of study and in real life.

Mathematical communication aims to help students articulate their thoughts and engage in critical thinking (Hasugian et al., 2024). To ensure that students are proficient in expressing ideas, as well as recognizing and solving mathematical challenges in everyday situations, it is crucial to actively use these mathematical communication skills. Communication skills are crucial for students to master, enabling them to process the information received and convey it appropriately, thus maximizing learning objectives.

Problem-solving and communication skills can be developed simultaneously in the learning process. Training students to have communication and problem-solving skills can be attempted by guiding students to investigate a problem, write about the problem, provide information or guesses (hypotheses) to explain observations in the learning material (Ariani et

al., 2017). Meanwhile, findings in the field, both abilities are still low. The teaching patterns that have been used by teachers have not been able to help students in solving problems in the form of questions, activate students in learning, motivate students to express their ideas and opinions, and students are even still hesitant to ask teachers if they do not understand the material being taught. To improve problem-solving and communication skills in physics learning, teachers must strive for learning by using learning models and media that can provide opportunities and encourage students to practice problem-solving and communication skills, such as the use of interactive learning models and media (Daryanto, 2013).

The results of (Saputra, 2017) research show that the implementation of ICARE assisted by E-modules can improve student learning outcomes in each cycle, namely cycle I (79.8), cycle II (84.6) and cycle III (88.6). Likewise, the results of research by Siahaan et al, (2020) which stated that the use of the ICARE model can improve students' collaboration and communication skills, where the results obtained for students' collaboration skills with an average score of 7.87 in the first meeting to 15.93 in the second meeting. Meanwhile, communication skills obtained an average score of 1.53 in the first meeting to 3.6 in the second meeting.

While Saputra (2017) study applied the ICARE learning model with the help of e-modules to improve student learning outcomes, Aisyah et al, (2022) developed an ICARE-based junior high school science learning module for the interaction of living things with the environment without using modules. In this study, researchers will develop an e-learning module integrated with the ICARE learning model for the Pressure of Substances material to improve problem-solving and communication skills.

Based on the description above, the researcher is interested in conducting research, namely compiling a physics learning e-module based on ICARE (introduction, connecting, application, reflection, extension) to improve students' problem-solving and communication skills on the material on substance pressure.

## 2. RESEARCH METHODS

This type of research is Research and Development (R&D) using the ADDIE development model which consists of five stages, namely (1) Analysis; (2) Design; (3) Development; (4) Implementation; and (5) Evaluation which aims to develop a physics learning e-module based on introduction, connection, application, reflection, and extension (ICARE) on the material of Pressure that is well qualified. In the implementation stage, the

product will be applied to problem-solving and communication skills using a pre-experimental design with a one group pretest-posttest design combined with a one-shot case study design which is used to determine the level of effectiveness of the application of the product developed.

This research was conducted at SMPN 4 Tanantovea, located in Guntarano, Tanantovea District, Donggala Regency, Central Sulawesi. The research was conducted during the even semester of the 2023/2024 academic year.

The population of this study was eighth-grade students at SMPN 4 Tanantovea. The sample was student of class VIIIIB SMPN 4 Tanantovea in the 2023/2024 academic year. The sample selection was based on recommendations from science teachers.

## **A. Research Procedures**

This research procedure uses a model developed by Branch (2009) namely ADDIE, which consists of five stages, namely Analyze, Design, Development, Implementation and Evaluation.

### **1. Analysis**

Analysis is the initial stage in the ADDIE development model. This stage is necessary to identify specific needs in developing a product. There are two analyses in this stage: needs analysis and materials analysis. The needs analysis was conducted through interviews with teachers and students of class VIII B at SMPN 4 Tanantovea. Material analysis was conducted by observing the curriculum and syllabus used in the school, so that the materials to be used in learning based on the introduction, connection, application, reflection, and extension (ICARE) learning model were developed in accordance with the subject outcomes that students must achieve.

### **2. Design**

The next stage is designing or developing a product based on the needs, characteristics of the students, and the learning materials. The product design developed is an introduction, connection, application, reflection, and extension (ICARE)-based learning e-module using Microsoft Word and Canva.

### **3. Development**

During the development phase, the initial draft of the introduction, connection, application, reflection, and extension (ICARE)-based physics learning e-module was completed. After the product development draft was completed, validation was conducted. Validation of the learning e-module aims to assess the feasibility of the product design.

#### **4. Implementation**

This stage is the trial stage of the learning e-module that has been created to determine the practicality, implementation and effectiveness of the e-module that has been developed. The trial in this study was carried out on a limited basis, namely to twenty (20) students, as well as 2 observers who will assess the implementation and practicality of the learning e-module that was created. Students will undergo a series of tests to test the effectiveness of the product, and observers will fill out a prepared observation sheet. The effectiveness test was carried out by administering a test using a one-group pretest-posttest design, and using an observation sheet. The test in this study was conducted to determine the problem-solving skills of students using the developed learning e-module. The pretest was conducted to determine the initial state of the problem-solving abilities of students before carrying out learning activities using the developed product. The posttest was conducted to determine the improvement in the problem-solving abilities of students after using the developed product.

Assessment using observation sheets was conducted to determine students' communication skills. The assessments were conducted by researchers throughout the learning process and were conducted three times, depending on the number of meetings. This was done to determine the improvement in students' communication skills from the first to the third or final meeting during the use of the introduction, connection, application, reflection, and extension (ICARE)-based physics learning e-module.

Test the implementation and practicality of the e-module, namely using an observation sheet that will be assessed by observers, namely the subject teacher and one of the students who will participate in the process during the learning process using the e-module.

#### **5. Evaluation**

Evaluation is the process of obtaining feedback from various parties regarding the learning media that has been created and developed. To determine user responses to the developed product, a questionnaire is required for students and teachers as respondents. The evaluation stage can occur at any stage. Next, the revised results are piloted with students to determine their perceptions of the product. Suggestions from students and teachers are then analyzed and revised until a final product is suitable for use at each stage.

##### **B. Data collection technique**

##### **1. Test**

In this study, a descriptive test was used to measure students' problem-solving abilities, as it has advantages in cognitive understanding, such as analyzing, synthesizing, and



evaluating. The test consisted of five questions tailored to problem-solving ability indicators, which were then analyzed descriptively. The test was administered twice: before learning (pretest) and after learning (posttest) in the classes serving as the research sample.

## **2. Questionnaire**

A questionnaire is a method of collecting data by providing respondents with a set of written questions or statements, which can be multiple-choice or in the form of an attitude scale. In this study, the questionnaire was used to test the practicality, implementation, and feasibility of the product.

## **3. Observation Sheet**

The observation used in this study was systematic observation using an observation sheet. This observation sheet is a method or way to analyze and systematically record behavior by directly observing individuals or groups. This method is used to provide researchers with a broader picture of the problem being studied. This observation sheet is used to capture indicators of students' communication skills. This observation sheet uses a Likert scale with four categories.

## **3. RESULTS AND DISCUSSIONS**

### **A. Analysis**

#### **Needs Analysis**

The needs analysis was conducted through interviews with physics teachers and eighth-grade students at SMPN 4 Tanantovea to determine the challenges they face in learning physics. The interviews revealed that electronic learning materials, such as e-modules, have never been used in the classroom. The learning process relies solely on printed textbooks/packages, resulting in suboptimal learning outcomes. Furthermore, teachers require supporting learning materials to assist in achieving their learning objectives. Teachers have also never used the introduction, connecting, application, reflection, and extension (ICARE) learning model in the learning process. Teachers generally only use problem-based learning (PBL), inquiry, and cooperative learning models.

When e-modules were introduced to learning, students were enthusiastic, as they had never used them before. Students often feel bored with print-based teaching materials. They wanted innovative and interactive teaching materials like e-modules, which include images or videos and can be accessed via mobile phones and computers.



### **Characteristic Analysis**

Analysis of student characteristics was obtained from the results of direct classroom observations. The results of the analysis of student characteristics obtained were the lack of student interest in learning, students tended to be lazy to open textbooks before the learning process began, there were several students who did not bring textbooks because they were too thick and heavy, polite, there were several students who rarely worked on questions given by the teacher, were less active in the learning process (tended to be silent), there were still several students who obtained scores below the KKM, and students understood explanations more quickly through multimedia, such as videos.

This also with previous research conducted by (Mawarni & Sinuraya, 2022) that found that learning outcomes for students using interactive e-modules were higher and could improve student understanding. Furthermore, the ability of e-modules to include text, images, videos, and quizzes facilitates student learning. The variety of media available allows for greater engagement with the senses needed for learning.

### **Material Analysis**

Analysis of the material obtained revealed that in grade VIII, there is one core competency (KD) that allows for the development of a physics learning module based on introduction, connecting, application, reflection, and extension (ICARE). This core competency is KD 3.8 "Explaining the pressure of matter and its application in everyday life."

The pressure of matter material has several sub-topics containing calculations, as well as several sub-topics that allow students to conduct simple experiments. This can be used to measure students' problem-solving abilities through problem-solving, as well as communication skills, which can be measured through group discussions.

From a material perspective, the pressure of matter material requires a more contextual understanding, so further elaboration is needed to ensure the material can be understood in a concrete form. In the learning process, in addition to mastering the material and concepts, students are also required to master 21st-century skills, including problem-solving and communication (Redhana, 2019). Therefore, researchers want to develop digital teaching materials using the ICARE model for the pressure of matter material that can train students' problem-solving and communication skills.

## **B. Design**

At this stage, the researcher began designing the module to be created. The e-module is divided into three parts: the beginning of the module, the core/content of the module, and the end of the module.

The beginning of the module consists of the cover page, foreword, table of contents, instructions for using the e-module, a description of the e-module, and a concept map. The cover page contains the material title, author's name, school level, class, semester, Institution logo, Tutwuri Handayani logo, and illustrations related to the material on substance pressure.

The core/content of the module contains material contained in the chapters and sub-chapters on substance pressure. This includes written explanations and learning videos, example problems and their solutions, practice problems, and evaluation problems. The learning activities in the e-module consist of five activities aligned with the ICARE learning model: introduction, connection, application, reflection, and extension.

The final part of the module is to create a summary of the material, glossary, bibliography and author biodata.

## **C. Development**

### **E-Module Development**

The first step in developing an e-module is to gather all the materials, including learning videos or written materials, sample problems and their solutions, practice problems, and evaluation questions, which will be included in the e-module.

The next step is to combine the beginning, core/content, and end of the module to produce a good module product according to the Ministry of National Education (2008). In developing or creating the e-module, the author used two applications: Canva and FlipHTML5. Canva was used to design the e-module, from the beginning, the core/content, to the end. FlipHTML5 was used to convert the module into an electronic module (e-module).

### **E-module validation process**

The developed module was then validated by expert validators. The purpose of this validation was to measure and evaluate the level of validity of the developed product. The product validation results can be seen in Table 1.

Table 1. E-module validation results

| No                | Evaluation aspects                                   | Score               |                     |
|-------------------|------------------------------------------------------|---------------------|---------------------|
|                   |                                                      | Expert <sup>1</sup> | Expert <sup>2</sup> |
| 1                 | Physical Appearance Module                           | 42                  | 39                  |
| 2                 | Introduction Aspect                                  | 15                  | 14                  |
| 3                 | Learning Aspect                                      | 29                  | 28                  |
| 4                 | ICARE Model Aspect                                   | 34                  | 34                  |
| 5                 | Content Aspect                                       | 25                  | 27                  |
| 6                 | Assignment / Evaluation / Assessment Aspect          | 36                  | 33                  |
| 7                 | Module Characteristics “ <i>Self Instructional</i> ” | 35                  | 36                  |
| 8                 | Module Characteristics “ <i>Self Contained</i> ”     | 11                  | 10                  |
| 9                 | Module Characteristics “ <i>Stand Alon</i> ”         | 7                   | 8                   |
| 10                | Module Characteristics “ <i>Adaptif</i> ”            | 11                  | 10                  |
| 11                | Module Characteristics “ <i>User Friendly</i> ”      | 10                  | 11                  |
| 12                | Summary Aspect                                       | 19                  | 22                  |
| <b>Total</b>      |                                                      | <b>173</b>          | <b>185</b>          |
| <b>Average</b>    |                                                      | <b>3.61</b>         | <b>3.57</b>         |
| <b>Percentage</b> |                                                      | <b>90%</b>          | <b>89%</b>          |
| <b>Criteria</b>   |                                                      | <b>Valid</b>        | <b>Valid</b>        |

Validation results on validator 1 obtained an average score of 3.61, a percentage of 90%, with a valid category, and on validator 2 obtained an average score of 3.57, a percentage of 89%, with a valid category (Table 1). The average value was obtained from 12 assessment aspects, namely the physical appearance of the module, introduction, learning, ICARE model, content, assignments/evaluation/assessment, module characteristics (self-instructional, self-contained, stand-alone, adaptive, user-friendly), and summary. The validated e-module is included in the valid category, so it can be used in learning. However, improvements still need to be made based on the improvement suggestions given by the 2 validators.

Based on the study conducted by Putra and Tambunan (2023), which applied the characteristics of self-instructional, self-contained, stand-alone, and user-friendly, the validation results were satisfactory or fell into the “highly satisfactory” category. Therefore, the developed learning e-module is considered highly feasible for use.

## D. Implementation

At this stage, a limited trial was conducted, where students engaged in learning activities using the developed product to test its practicality, implementation, and effectiveness. The practicality and implementation of the e-module were measured through questionnaires completed by observers, and the effectiveness of the e-module was measured through pre-test and post-test problem-solving skills tests and observation sheets on students' communication skills.

### Practicality of the Learning E-Module

The practicality of the e-module was determined through questionnaires completed by teachers at the end of the learning process. The results of the e-module's practicality are presented in Table 2.

Table 2. Results of the E-Module Practicality Test

| <i>No</i>         | <b>Evaluation aspects</b> | <b>Score obtained</b> | <b>Total score</b> |
|-------------------|---------------------------|-----------------------|--------------------|
| 1                 | Effective                 | 8                     | 8                  |
| 2                 | Interactive               | 8                     | 8                  |
| 3                 | Efficient                 | 7                     | 8                  |
| 4                 | Creative                  | 8                     | 8                  |
| <b>Total</b>      |                           | <b>31</b>             | <b>32</b>          |
| <b>Average</b>    |                           | <b>7.75</b>           | <b>8</b>           |
| <b>Percentage</b> |                           | <b>97%</b>            | <b>100%</b>        |

Table 2 shows that the total score for the assessment aspects is 32, with each aspect receiving a score of 8. The total score obtained by the researcher is 31, which is in the very practical category, at 97%. This can be said to be very practical for use in learning. This is in line with a previous study by Mawarni and Sinuraya (2022), which stated that the ICARE-based e-module learning using Flip PDF is effective for use in school learning.

### E-Module Learning Implementation

The e-module implementation test was obtained through questionnaires completed by observers during the learning process. The e-module implementation results are presented in Table 3.

Table 3. E-Module Implementation Test Results

| No  | Evaluation aspects    | Observer 1 |             |            | Observer 2  |            |            |
|-----|-----------------------|------------|-------------|------------|-------------|------------|------------|
|     |                       | 1          | 2           | 3          | 1           | 2          | 3          |
| I   | Introduction          |            |             |            |             |            |            |
|     | Introduction          | 15         | 18          | 19         | 17          | 19         | 20         |
| II  | Core                  |            |             |            |             |            |            |
|     | Connecting            | 6          | 7           | 8          | 6           | 8          | 8          |
|     | Application           | 6          | 8           | 8          | 8           | 8          | 8          |
|     | Reflection            | 6          | 6           | 7          | 7           | 7          | 8          |
| III | Conclusion            |            |             |            |             |            |            |
|     | Expansion             | 12         | 15          | 16         | 12          | 15         | 16         |
| III | Classroom Atmosphere  | 10         | 12          | 14         | 12          | 13         | 14         |
| IV  | Time Management       | 3          | 3           | 4          | 3           | 3          | 4          |
|     | <b>Total</b>          | <b>58</b>  | <b>69</b>   | <b>76</b>  | <b>65</b>   | <b>72</b>  | <b>78</b>  |
|     | <b>Average</b>        | <b>2.9</b> | <b>3.45</b> | <b>3.8</b> | <b>3.25</b> | <b>3.6</b> | <b>3.9</b> |
|     | <b>Percentage (%)</b> | <b>73%</b> | <b>86%</b>  | <b>95%</b> | <b>81%</b>  | <b>90%</b> | <b>98%</b> |

Table 3. shows that the e-module implementation score for observer 1 in the first meeting was 58 with an average score of 2.9 percentage 73%. The second meeting scored 69 with an average score of 3.45 percentage 86%, and the third meeting scored 76 with an average score of 3.8 percentage 95%. Observer 2, meanwhile, scored 65 with an average score of 3.25 percentage 81%, followed by a score of 72 with an average score of 3.6 percentage 90%, and a score of 78 with an average score of 3.9 percentage 98%.

These results indicate that the implementation of e-module use in learning improved from the first to the third meeting. These scores were obtained from the observers' questionnaires, which covered several assessment aspects, including the introduction, main points, conclusion, classroom atmosphere, and time management. The total score for the assessment aspect of the implementation of the use of e-modules is 80. So, from the total score obtained, researchers can calculate the average number and percentage of implementation of learning using e-modules. Aisyah et al. (2023) also conducted a study on the development of a module based on the ICARE learning model. The researchers stated that the ICARE-based learning module has the potential to be used in teaching Natural Science (IPA) materials.

### Effectiveness of Learning E-Modules

The effectiveness of the learning e-modules was measured through the results of problem-solving ability tests and observation sheets on students' communication skills.

### Problem-Solving Ability

The effectiveness of the learning e-modules on problem-solving ability can be seen from the results of the pretest and posttest obtained by students. The pretest was administered before the learning activity began to measure the extent of students' problem-solving ability on the pressure material. The posttest was administered after learning using the learning e-modules to assess the effectiveness of the product's use. The test consisted of five essay questions. Improvement in students' problem-solving ability was determined using Cohen's d effect size calculation. The results of the e-module effectiveness test on students' problem-solving ability can be seen in Table 4.

Table 4. Problem-Solving Ability Test Results

| <b>Description</b>           | <b>Pretest</b>                          | <b>Posttest</b> |
|------------------------------|-----------------------------------------|-----------------|
| Sample                       | 20                                      | 20              |
| Average                      | 23.80                                   | 81.60           |
| Ideal Score                  | 100                                     | 100             |
| Standard Deviation           | 6.71                                    | 9.30            |
| t-test                       | <b><math>6.7 \times 10^{-18}</math></b> |                 |
| <b><i>Effect Size</i></b>    | <b><i>7.126</i></b>                     |                 |
| <b><i>Interpretation</i></b> | <b><i>Significant</i></b>               |                 |

Based on Table 4 above, it can be seen that the average pretest score obtained by 20 students of class VIII B was 23.8 out of an ideal score of 100, with a standard deviation of 6.71. Meanwhile, the posttest results for the same group of students showed an average score of 81.60 out of an ideal score of 100, with a standard deviation of 9.30. This indicates that, in general, there was an improvement in the students' problem-solving abilities after using the ICARE-based (Introduction, Connection, Application, Reflection, Extension) learning e-module. The data above also shows a very large effect size of 7.126. The resulting effect size indicates that the use of the introduction, connection, application, reflection, and extension (ICARE)-based physics learning e-module on the topic of substance pressure significantly improved students' problem-solving abilities. According to the study conducted by Risda et al (2021), based on the effect size calculation, the effectiveness of the ICARE learning model on creative thinking skills in the topic of optical instruments showed that students' pretest scores averaged 31.125, while their posttest scores increased to 68.458. The calculation produced a

Cohen's *d* value of 3.47. According to Cohen's effect size criteria, this value falls into the large effect category. Therefore, it can be stated that the effectiveness level of the ICARE learning model in improving creative thinking skills is very high or highly effective.

### Communication Skills

Students' communication skills were measured using an observation sheet with 12 assessment aspects. The observation sheet was validated by an expert validator. The assessment of communication skills was conducted by comparing the overall percentage scores obtained by students from the first to the last meeting. The results of the students' communication skills data can be seen in Table 5.

Table 5. Description of Students' Communication Skill Scores

| Description        | Session 1 | Session 2 | Session 3 |
|--------------------|-----------|-----------|-----------|
| <i>Total score</i> | 464       | 571       | 807       |
| <i>Average</i>     | 23.2      | 27        | 34.4      |
| <i>Percentage</i>  | 46%       | 56%       | 72%       |

Table 5 shows that the average score of students' communication skills increased from the first meeting to the third meeting. At the first meeting, the average score obtained was 23.2 with a percentage of 46%, the second meeting, the average score obtained was 27 with a percentage of 56%, and the third meeting, the average score obtained was 34.4 with a higher percentage, namely 72% with a good category. Similarly, the results of the study by Siahaan et al. (2020) stated that the use of the ICARE model can improve students' communication skills, as shown by the increase in their communication abilities from the first meeting to the final meeting.

In the second meeting, a significant improvement was observed. Students began actively responding to questions, engaging in group discussions, and demonstrating the ability to express ideas more coherently and confidently. The ICARE-based e-module helped students understand the structure of effective communication and provided space for both independent and collaborative practice. By the final meeting, students had shown much better communication skills compared to the beginning of the learning process. They were able to master all the indicators of communication competence. This improvement indicates that the use of the ICARE-based e-module as a learning medium can effectively support the development of students' communication skills.



## E. Evaluation

The final stage of this e-module development was an evaluation to determine the feasibility of the introduction, connection, application, reflection, and extension (ICARE)-based physics learning module for students. The success of this e-module development was measured by the feedback provided by students based on the questionnaire they completed. The results of the student response questionnaire analysis are shown in Table 6.

Table 6. Results of the Student Response Questionnaire Analysis

| No                | Evaluation aspects        | Score       | Average      |
|-------------------|---------------------------|-------------|--------------|
| 1                 | Content Validity          | 589         | 29.45        |
| 2                 | Language Accuracy         | 456         | 22.8         |
| 3                 | Practical Usefulness      | 515         | 25.8         |
| 4                 | Graphical Appropriateness | 589         | 29.5         |
| <b>Total</b>      |                           | <b>2149</b> | <b>26.88</b> |
| <b>Percentage</b> |                           | <b>93%</b>  |              |

Based on Table 6 above, the average score for student responses obtained was 26.88, representing 93% of the population, categorized as very suitable. This indicates that the physics learning e-module based on introduction, connection, application, reflection, and extension (ICARE) on the pressure of matter material is suitable for use in learning. This is in line with the study conducted by Mawarni and Sinuraya (2024), which found that the ICARE-based e-module learning is highly suitable for use in classroom learning, as reflected in the evaluated aspects.

## 4. CONCLUSIONS AND SUGGESTIONS

### CONCLUSIONS

The ICARE-based (Introduction, Connecting, Application, Reflection, Extension) physics learning e-module that was developed can be used to improve students' problem-solving abilities, as indicated by the obtained effect size value of 7.126, which is interpreted as having a very large effect and communication skills, as shown by the overall analysis results obtained 46% in the first meeting, 56% in the second meeting, and 72% in the third meeting falling into the effective category.

## SUGGESTIONS

The use of ICARE-based e-modules in other physics materials can be used to measure and improve students' abilities and skills in various aspects.

Further researchers can conduct this study in greater depth, examining the shortcomings and limitations of this study to provide lessons and guidelines for better research. It is recommended that multiple classes or schools be used.

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## BIBLIOGRAPHY

- Aisyah, E., Diniya, & Susilawati. (2023). Pengembangan Modul Pembelajaran IPA SMP/MTs Berbasis Icare (Introduction, Connection, Application, Reflection, Extension) Pada Materi Interaksi Makhluk Hidup Dengan Lingkungan Oleh. *Journal of Natural Science Learning*, 02(02), 38–60.
- Ani, S., & Priandsa, D. J. (2017). *Manajemen peserta didik dan model pembelajaran*. Alfabeta.
- Ariani, S., Hartono, Y., & Hiltrimartin, C. (2017). Kemampuan Pemecahan Masalah Matematika Siswa pada Pembelajaran Matematika Menggunakan Strategi Abduktif-Deduktif di SMA Negeri 1 Indralaya Utara. *Jurnal Elemen*, 3(1), 25. <https://doi.org/10.29408/jel.v3i1.304>
- Azizah, R., Yuliati, L., & Latifa, E. (2017). Kemampuan Pemecahan Masalah Melalui Pembelajaran Interactive Demonstration Siswa Kelas X SMA pada Materi Kalor. *Jurnal Pendidikan Fisika Dan Teknologi*, 2(2), 55–60. <https://doi.org/10.29303/jpft.v2i2.289>
- Branch, R. (2009). *Intructional Design: The ADDIE Approach*. Springer US.
- Daryanto. (2013). *Media pembelajaran: peranannya sangat penting dalam mencapai tujuan pembelajaran*. Gava Media.
- Hamid, A., & Alberida, H. (2021). Pentingnya Mengembangkan E-Modul Interaktif Berbasis Flipbook di Sekolah Menengah Atas. *Edukatif: Jurnal Ilmu Pendidikan*, 3(3), 911–918. <https://doi.org/10.31004/edukatif.v3i3.452>
- Hartono. (2019). Hambatan belajar epistemologis siswa pada materi tekanan zat cair melalui analisis tes kemampuan responden. *Jurnal Inovasi Dan Pembelajaran Fisika*, 6(2), 191–199.
- Hasugian, G. S. L., Novita Sari, D., Ramadhani, R., Burlianda, B., & Gloria Sinaga, M. (2024). Meningkatkan Kemampuan Komunikasi Matematis Siswa Dan Self Confidence Melalui Penerapan Model Problem Based Learning Di SMA Negeri 1 Tanjung Morawa. *Journal on Education*, 6(4), 19756–19767. <https://doi.org/10.31004/joe.v6i4.5993>

- Kurniawati, I., Raharjo, T. J., & Khumaedi. (2019). Peningkatan Kemampuan Pemecahan Masalah untuk Mempersiapkan Generasi Unggul Menghadapi Tantangan abad 21. *Seminar Nasional Pascasarjana*, 21(2), 702.
- Lestari, S. (2018). Peran teknologi dalam pendidikan di era globalisasi Edurelegia. *Jurnal Pendidikan Agama Islam*, 2(2), 94–100.
- Mawarni, N., & Sinuraya, J. (2022). Uji Kelayakan E-Modul Berbasis ICARE Menggunakan Flip Pdf Profesional pada Materi Vektor. *Jurnal Ikatan Alumni Fisika*, 8(2), 5. <https://doi.org/10.24114/jiaf.v8i2.33785>
- Nopiani, R., Made Suarjana, I., & Sumantri, M. (2021). EModul Interaktif Pada Pembelajaran Tematik Tema 6 Subtema 2 Hebatnya Citacitaku. *MIMBAR PGSD Undiksha*, 9(2), 276. <https://doi.org/10.23887/jjpgsd.v9i2.36058>
- Putra, M. N., & Tambunan, H. (2023). Pengembangan E-Modul Pembelajaran Teknik Instalasi Tenaga Listrik Berbasis Android di SMK Medan. *Jurnal of Electrical Vocational Teacher Education*, 3(1), 79-88.
- Rahmawati, L., Juandi, D., & Nurlaelah, E. (2022). STEM implementation in improving mathematical critical and creative thinking skills. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 11(3), 2002–2014.
- Redhana, I. W. (2019). Mengembangkan Keterampilan Abad Ke-21 Dalam Pembelajaran Kimia. *Jurnal Inovasi Pendidikan Kimia*, 13(1).
- Risda, D., Parsaoran, S., & Efendi, R. 2021. Efektivitas Model ICARE untuk meningkatkan Keterampilan Berfikir Kreatif Alat Optik. *Jurnal Hasil Kajian, Inovasi, dan Aplikasi Pendidikan Indonesia*. 7(1), 193-198
- Saputra, Y. D. (2017). Penerapan Strategi I-Care berbantuan E-Modul untuk Meningkatkan Hasil Belajar Materi Bangun Ruang Sisi Lengkung. *Jurnal Pendidikan : Riset Dan Konseptual*, 1(1), 38. [https://doi.org/10.28926/riset\\_konseptual.v1i1.5](https://doi.org/10.28926/riset_konseptual.v1i1.5)
- Siahaan, P., Dewi, E., & Suhendi, E. (2020). Introduction, connection, application, reflection, and extension (ICARE) learning model: The impact on students' collaboration and communication skills. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, 9(1), 109. <https://doi.org/10.24042/jipfalbiruni.v9i1.5547>
- Sri Jayanti, N. P., Ardana, I. M., & Pasek Suryawan, I. P. (2019). Pengaruh Model Pembelajaran Improve Berbantuan Masalah Terbuka Terhadap Kemampuan Pemecahan Masalah Matematika Siswa Kelas Viii Smp Laboratorium Undiksha. *Jurnal Pendidikan Matematika Undiksha*, 10(2), 9. <https://doi.org/10.23887/jjpm.v10i2.19909>
- Tafonao, T. (2018). Peranan Media Pembelajaran Dalam Meningkatkan Minat Belajar Mahasiswa. *Jurnal Komunikasi Pendidikan*, 2(2), 103. <https://doi.org/10.32585/jkp.v2i2.113>
- Walid, A. (2017). *Strategi pembelajaran IPA* (Cet. 1). Pustaka Pelajar.
- Yani, Y. (2018). *Pengembangan modul pembelajaran berbasis ICARE (introduction, connection, application, reflection, extention) pada mata pelajaran matematika peserta didik SMP/MTs*. Doctoral dissertation, UIN Ar-Raniry Banda Aceh.
- Zubaidah, S. (2019). Pendidikan Biologi dalam Perkembangan Revolusi Industri. *Seminar Nasional Pendidikan Biologi Dengan Tema “Biologi Di Era Revolusi Industri 4.0: Riset Dan Pembelajaran” Di FKIP Univesitas Negeri Jakarta, December*, 1–22.