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Development of E-Modules Based on the ICARE Learning Model to Improve Students' Creative Thinking and Scientific Communication Skills

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Abstract: This research aims to develop E-module teaching materials based on the ICARE learning model to improve high school students' creative thinking and scientific communication skills. The research method used in this research is the plomp model. The Plomp model consists of three stages, namely preliminary research, development or prototyping phase, assessment phase. Validation test using Aiken's V and Practicality formula. The results of the E-module validity test based on the ICARE learning model carried out by three validator experts obtained valid criteria, so that the e-module is suitable for use in learning activities. The teacher's practicality obtains very practical criteria, the students' practicality is in the very practical category. So, e-modules are very suitable for use in learning activities. E-modules based on the ICARE learning model have proven capable of improving high school students' creative thinking and scientific communication skills. The aim of this research is to see the practicality of e-modules based on the ICARE learning model to improve students' creative thinking and scientific communication skills.

Keywords: Creative thinking; E-module; Scientific communication

Introduction

Education is a long-term investment in human resources (HR) which has strategic value for the continuity of human civilization in the world (Cayrat et al., 2023). So, one important component in education is the teacher. Teachers in the educational context have a large and strategic role. This is because teachers are at the forefront in the implementation of education (Oviyanti, 2016; Reuge et al., 2021; Reyes-Cortés et al., 2018). Learning is a communication process between students, teachers, and teaching materials. Communication will not work without the help of a means of conveying the message or media. Therefore, efforts need to be made to improve the learning process by utilizing information technology-based teaching materials or media to increase students' competence (Abdulrahaman et al., 2020; David et al., 2023).

The Industrial Revolution 4.0 has brought changes in various aspects of human life technologically from the current generation and the traditional methods used in teaching and learning, educators at all levels will find it more difficult to improve the teaching and learning experience in the classroom (Dwivedi et al., 2023). The development of technology, information and communication in the 4.0 revolution can help in learning activities which provide a new atmosphere in change activities (Javaid et al., 2022; Javed et al., 2019). The learning process has an influence on achievement in education because learning is a process of interaction between students and learning resources in a learning environment. The existence of learning resources has an important role in achieving student learning goals (Far

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et al., 2021; Wahyuningsih et al., 2021). Learning resources are various or all sources in the form of data, people and certain forms that can be used by students in learning activities either separately or in combination, making it easier for teachers to achieve their learning goals (Darling-Hammond et al., 2020). Therefore, teachers are required to be more creative and innovative in teaching materials for the current learning process.

The independent curriculum is a breakthrough in the world of Indonesian education in the 21st century which gives students the freedom to learn and search for talents independently to improve students' creative thinking and scientific communication skills by utilizing technology and independent learning which will improve teacher abilities and student learning outcomes (Intiana et al., 2023). Indirectly, if educators experience limitations in integrating information technology, this can become an obstacle to students' development in utilizing the potential of this technology optimally.

It is hoped that the efforts and efforts made by the government and schools will enable students to learn independently to improve students' creative thinking and scientific communication skills, but the reality in the field is not yet in accordance with the ideal conditions expected. This can be shown from data from the PISA (Program for International Student Assessment) study that Indonesia was ranked 64th out of 65 countries in 2012, while in 2015 it was ranked 64th out of 72 countries. In 2018 Indonesia was ranked 72nd out of 78 countries, while in 2022 Indonesia was ranked 68th out of 81 countries. Even though Indonesia's PISA ranking has increased, the decline in Indonesia's PISA score is thought to have decreased due to lagging behind in learning or learning loss during the Covid-2019 pandemic.

In fact, in general physics science teachers tend to use the lecture method (Puspitasari et al., 2021); (Karyadi et al., 2018; Puspitasari et al., 2021). Physical science teachers tend to use this method due to limited time, lack of material and inadequate infrastructure (Munzil et al., 2022). Learning that does not involve students actively causes a lack of balance in students' cognitive, affective and psychomotor abilities (Darling-Hammond et al., 2020; Darma, 2019). One solution to answer the problems above is to use digital teaching materials, namely E-modules, to improve students' creative thinking and scientific communication in physics learning (Christiani et al., 2021; Endaryati et al., 2023; Julianto et al., 2022). Because E-modules can be accessed independently and can make the learning process more interesting, interactive, can be done anytime and anywhere and can improve the quality of learning (Mudzofar et al., 2023; Purwanti et al., 2023).

Based on the background stated, there is a gap between the ideal reality expected in achieving educational goals. So, researchers are interested in developing digital teaching materials, namely E-modules based on the ICARE learning model (Gultom et al., 2023; Ita et al., 2022; Kusyanti, 2021). This research aims to develop E-module teaching materials based on the ICARE learning model to improve creative thinking and scientific communication of high school students.

Method

The research used is research and development. Development research is needed to design and develop a product as a solution to solving a complex problem. The development model in this research is the Plomp model. The Plomp model consists of three stages, namely preliminary research, development or prototyping phase, assessment phase. The first stage of preliminary research carried out was needs analysis and reviewing literature. Preliminary research activities aim to serve as a guide in developing a product (Snyder, 2019). By conducting a needs analysis and reviewing the literature, we can find out what is happening in the field.

The second stage, development or prototyping phase, is the product development stage, namely designing digital E-module teaching materials using the Adobe Animate application with temperature and heat material. After making the product, the next step is to carry out validity tests and revise them according to the validator's suggestions. Plomp's theoretical product prototyping process is as follows:

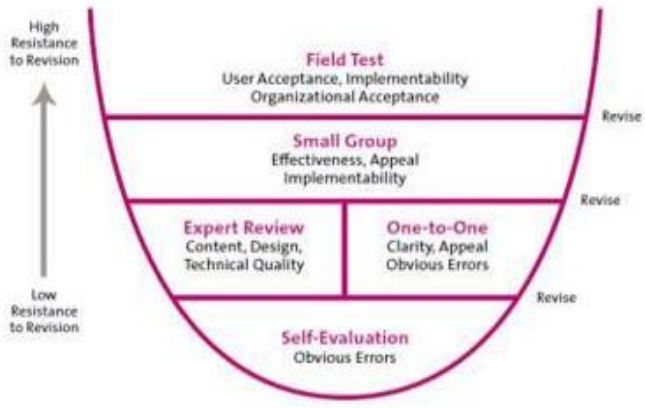

Figure 1. Formative evaluation (Plomp, 2013)

Firstly, Self-evaluation is carried out to check, repair and re-read all parts of the E-module product. The instrument that will be used is a self-assessment instrument. Expert review is a validity testing stage by experts. Validation is carried out by 3 experts. The instrument used for product validation is the E-module product validation instrument sheet. After validation by experts, improvements are made based on the suggestions given to produce quality and valid

products. The equation used to determine the validity test is Aiken's V.

$$V = \frac{\Sigma s}{n(c-1)} \quad (1)$$

Information

$$s = r - l_0 \quad (2)$$

Information:
V = Rater agreement index
l0 = Lowest validity assessment number (in this case = 1)
c = The highest validity assessment number (in this case = 5)
n = Number of raters

The validity criterion is that the e-module is valid if the V value is > 0.92. The word valid means appropriate, correct and legitimate. Valid is an instrument that can be used to measure what should be measured. Validation is carried out by several experts or expert practitioners, namely learning media using validation sheets. Furthermore, if it has been declared valid it will be implemented at the target school. At this stage we will see whether the product being developed can improve students' creative thinking and scientific communication skills by carrying out a One-to-One evaluation test to test the practicality of the E-module product. The practicality test was carried out on 3 students, representing low, medium and high abilities. The instrument used to test practicality is the E-module Product practicality instrument. Revisions are made if the product is in the low category.

After that, it was tested again in small group evaluation, which is a limited trial stage in testing the practicality and effectiveness of the product in small groups. The practicality test was carried out on 9 students representing low, medium and high abilities. The instrument used to test practicality is the E-module Product Practicality instrument. Revisions are made if the product is in the impractical category. The instrument used to test product effectiveness is the essay question test instrument. A field test is a field test or test of a product being developed, and tested on students when the product is complete. The following is the equation for testing the practicality of E-module teaching materials

$$\text{Mark} = \frac{Total\ Weight}{maximum\ weight} \times 100 \quad (3)$$

The third stage is the assessment phase, namely the product trial stage through the use of the product on students after testing the practicality of the product on 1 class or large group and can see an increase in learning outcomes and the effectiveness of the product produced.

Result and Discussion

Results

Findings from observations made on students and teachers are that the teaching materials used in schools still use printed teaching materials and there are no teaching materials that students can access independently. So, researchers are interested in developing e-modules based on the ICARE learning model to improve students' creative thinking and scientific communication skills (Aini et al., 2023; Nurlaela et al., 2019; Suciati et al., 2023). The following is the form of the E-module teaching materials.

Figure 2. Part of the content of the e-module based on the ICARE learning model

The results of the E-module based on the ICARE learning model to improve students' scientific communication are measured using valid, practical and effective aspects. The validity value of the E-module based on the ICARE learning model was obtained from the validity of experts in the form of physics education lecturers at Padang State University (UNP). Practicality Value of the E-module based on the ICARE learning model from the practicality test given to teachers and students of SMAN 7 Sarolangun.

Expert Validity Test Results

Based on the results of validity tests by three experts, the results showed that the development of E-modules based on the ICARE learning model to improve high school students' creative thinking and scientific communication skills was declared valid. In product validation there are several aspects, namely material substance aspects, learning design aspects, E-module display aspects and software utilization (Fauziah et al., 2023; Yulkifli et al., 2023). The validated E-module was revised so that it could become a quality E-module, so the results obtained from product validation by experts in the form of an E-module based on the ICARE learning

model to improve students' creative thinking and scientific communication skills can be seen in table 1.

Table 1. Results of E-module Product Validation by Experts

Description of the component's final score		
Material substance		0.93
Aspects of learning design		0.89
E-module display aspect		0.91
Utilization of software		0.95
Average	0.92	(Valid)

Table 1 shows that the average validation value of the E-module based on the ICARE learning model based on the validator value is 0.92. So, it can be concluded that the E-module based on the ICARE learning model is categorized as valid. Therefore, it can be tested in physics learning. After validating and revising the product according to the validator's suggestions, the next step is to conduct research. The research was conducted at SMA N 7 Sarolangun. This research aims to determine the feasibility of ICARE-based E-Modules, showing that ICARE-based E-Modules using Professional Pdf Flip are suitable for use in the learning process.

Research was also conducted by Destari et al. (2021) and Pratiwi et al. (2024) in his research finding the effectiveness of the ICARE learning model in improving creative thinking skills and scientific communication skills of high school students. It was stated that the ICARE learning model was effective in improving creative thinking skills. This research is also in line with research by Hidayat et al. (2023), that the E-module based on the results of a limited trial of the e-module was stated to be very practical with a percentage of 87.33%. So, it can be concluded that the ICARE-based e-module assisted by FlippingBook on SPLDV material is feasible and practical to use for the learning process. So that instruments that have been declared valid can be used to collect research data (Busetto et al., 2020; Sefrianto et al., 2020; Taber, 2018).

Practicality Test Results

Practicality by giving a questionnaire to 1 physics teacher at SMAN 7 Sarolangun regarding the practicality of E-modules based on the ICARE learning model to improve students' creative thinking and scientific communication skills. Several aspects assessed in the practicality test are aspects of ease of use, effectiveness of learning and benefits of the E-module. The results of the E-module practicality test based on the ICARE learning model can be seen from table 2.

Table 2 shows that the practicality value of e-modules based on the ICARE learning model has an average value of 99.25%, e-modules based on the ICARE learning model are said to be very practical in learning physics. So, E-modules based on the ICARE learning model can be applied to improve students' creative thinking and scientific communication skills (Laila et al., 2023; Zuhria et al., 2023). Not only teacher responses, student responses are also needed for the convenience and practicality of the product. Practicality was tested on class XI FA 2 students. A one-to-one test was carried out, namely 3 students who had low, medium and high abilities. Table 3 shows the one-on-one practicum carried out by 3 students.

Table 2. Results of Practicality of E-module Products by Teachers

Description of the component's final score	
Ease of use of E-modules	88
Learning effectiveness	100
Utilization of E-modules	100
Average	99.25 is very practical

Table 3. One to One Practicality of E-module

Name	Value score	Average
R1	93.60	
R2	80.80	81.86 (very practical)
R3	71.20	

Table 3 shows that for the one to one test carried out by 3 students who had low, medium and high abilities, they got a score of 81.86 in the very practical category. So, it can be tested on small groups or small groups consisting of 9 people, 3 people have low ability, 3 have medium ability and 3 have high ability, the test is carried out to get a product that is feasible and practical in the physics learning process. The following is table 4 practicalities E-module based on the small group ICARE learning model.

Table 4. Practicality of Small Group E-Modules

Name	Value score	Average
R1	96.80	
R2	93.60	
R3	80	
R4	100	88.90 (very practical)
R5	80.80	
R6	92	
R7	96.80	
R8	71.20	
R9	88.80	

Table 4 shows that the small group in the E-module based on the ICARE learning model received a score of 88.9 in the very practical category. After testing in small groups, the product was allowed to be applied to physics learning. After conducting physics learning using E-modules based on the ICARE learning model, large group practicality was carried out in 1 class. 97%

in the very practical category. So, it can be stated that e-modules based on the ICARE learning model can be applied in the learning process and are declared successful in the physics learning process (Gultom et al., 2023; Zuhria et al., 2023). Practicality tests start from assessing one answer based on the results of interviews, evaluations, small groups by providing practicality sheets and field tests by providing practicality instruments with parameters for the degree of usefulness, if teachers and other experts assess that the material can be applied (Dharmayanti et al., 2021; Jaafar et al., 2020).

Conclusion

Based on the research that has been carried out, the following conclusions are obtained. The E-module based on the ICARE learning model to improve high school students' creative thinking and scientific communication skills is declared valid. The e-module based on the ICARE learning model to improve creative thinking and scientific communication skills for high school students is stated to have very practical criteria from the results of practicality carried out by teachers at SMAN 7 Sarolangun. The e-module based on the ICARE learning model to improve high school students' creative thinking and scientific communication skills is stated to have very practical criteria from the practical results carried out by class XI students of SMAN 7 Sarolangun which are very practical. E-modules based on the ICARE learning model have proven capable of improving high school students' creative thinking and scientific communication skills.

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In this research, there is no tug of interest and or hidden interests among the researchers. In addition, this research is also not an order from any funder because it is an independent research or in other words, the research team itself plays a role in preparing proposals, selecting topics, conceptualizing problems, collecting data, analyzing problems, drawing conclusions until the publication stage in this text.

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