



THE EFFECTIVENESS OF PHYSICS E-MODULES BASED ON CREATIVE PROBLEM-SOLVING LEARNING MODEL INTEGRATED WITH 21st-CENTURY SKILLS

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ABSTRACT

The availability of teaching materials that contain 21st-century skills still needs to be improved. This research aims to look at the effectiveness of the 21st-century integrated CPS-based e-module that has been developed. This study is part of Research and Development research, using the Reeve Model with stages of analysis, design, and evaluation. Measurement of effectiveness is carried out at the evaluation stage. Effectiveness is measured by giving a pretest and posttest to students. The sampling technique used is a purposive sample. Effectiveness is measured by giving a pretest and posttest to students. There was an increase in student mastery of 21st-century skills from 78.32 to 84. Then, based on hypothesis testing, information was obtained that there were differences in student mastery of 21st-century skills before and after using the e-module (Sig (2-tailed) <0.05). It indicates the effect of using e-modules based on the CPS model integrated with 21st-century skills to improve student mastery of 21st-century skills and mastery of 21st-century skills.

EFEKTIVITAS E-MODUL FISIKA BERBASIS MODEL PEMBELAJARAN CREATIVE PROBLEM-SOLVING TERINTEGRASI KETERAMPILAN ABAD 21

ABSTRAK

Kata Kunci:

CPS
Efektivitas
E-modul
Keterampilan abad 21

Ketersediaan bahan ajar yang memuat keterampilan abad 21 masih kurang. Tujuan penelitian ini adalah melihat efektivitas e-modul berbasis CPS terintegrasi abad 21 yang telah dikembangkan. Penelitian ini merupakan bagian dari penelitian Riset dan Development, menggunakan Reeve Model dengan tahapan analisis, desain, dan evaluasi. Pengukuran efektivitas dilakukan pada tahap evaluasi. Efektivitas diukur dengan memberikan *pretest* dan *posttest* kepada siswa. Teknik sampel yang digunakan adalah *purposive sample*. Terdapat peningkatan hasil belajar siswa dari 78,32 menjadi 84. Berdasarkan uji hipotesis diperoleh informasi bahwa terdapat perbedaan penguasaan keterampilan abad 21 siswa sebelum dan setelah menggunakan e-module (Sig (2-tailed) <0.05). Hal ini mengindikasikan bahwa penggunaan e-modul berbasis model CPS terintegrasi keterampilan abad 21 efektif dalam meningkatkan hasil belajar dan penguasaan keterampilan abad 21 siswa

1. INTRODUCTION

The 21st century has brought many changes in all sectors of human life, including education [1], [2]. The hottest issues in education today are skills that must be mastered by students or the next generation [3]. 21st-century skills are core skills that young people must possess to compete globally [4], [5]. 21st-century skills consist of communication, collaboration, critical thinking, problem-solving, creativity, and innovation [6], [7]. 21st-century skills require creativity, problem-solving, perseverance, and the ability to work in teams [8]. To compete in the 21st century, students need to be equipped with the following abilities: 1) creative and innovative; 2) communicative and collaborative; 3) smooth research and information; 4) Critical Thinking 5) Digital Citizenship; and 6) Technology Operations and Concepts [9]. Furthermore, to master these skills, learning skills in the 21st century are needed, namely: 1) Information and communication skills; 2) Thinking and problem-solving skills; 3) Interpersonal and self-directional skills [3]. Teachers, as learning facilitators, are expected to be able to facilitate and guide students in the process of mastering 21st-century skills [10]. Teachers are expected to be able to adapt quickly to changes in the character of students, technological developments, or curriculum developments. It is important to integrate 21st-century skills into learning because Indonesia has entered the era of globalization, where Indonesian graduates must be able to compete globally [11]. Human resources are less able to compete with other countries. This is evidenced by the Ranking of PISA (Program for International Student Assessment), which ranks 60 out of 72 countries [12]. The PISA score illustrates students' low mastery of 21st-century skills in Indonesia.

Mastery of 21st-century skills by students needs to be facilitated by teachers by preparing meaningful learning [13]. 21st-century skills can increase students' creative problem-solving thinking [14]. The Creative Problem-solving (CPS) model can develop students' problem-solving creativity [15], [16]. Model CPS was implemented through the following stages: 1) Identifying Problems consists of Recognize Problem, Explore The Problem, and Construct The Problem; 2) Discovering Ideas, Idea Generation; 3) Finding Solutions, Idea Evaluation, finding the most appropriate idea; 4) Finding Execution stage, to plan and to execute the determined solution [17]. The CPS model can enable students to think critically and make the right problem-solving decisions [18].

Technological developments have brought changes in many sectors of life, one of which is education. The world of education has undergone many changes as technology has developed [5]. One of which is in the presentation of teaching materials. Previously the teaching materials presented by the teacher were in printed form, easily carried by students anywhere. Still, more suitable teaching materials are now provided in electronic form, for example, e-modules [19]. E-modules have several advantages over other teaching materials, namely: 1) e-modules are interactive, which makes them easier to navigate; 2) e-modules can display images, videos, audio, and animations; 3) e-modules can contain interactive quizzes, which allows immediate automatic feedback [20]. Using e-modules can also reduce production costs, are easy to access, practical, and can be opened wherever students are. However, infrastructure must support e-module access through a consistent internet network.

The problem often found in schools is the lack of learning resources that support competency achievement and are not following the character of the students/environment. Electronic books and teaching materials used in schools do not contain character values [21]. Teachers are expected to be able to develop teaching materials as learning resources [18]. Technological developments have required teachers to adapt from conventional teaching to modern teaching materials [22]. One of the

newest forms of teaching materials today is e-modules. Through learning with e-modules, learning patterns that allow students to learn independently and teachers are no longer the only sources of learning. The material in the e-module makes it easier for students to understand the explanation of the material because multimedia elements are mixed into the e-module [23]. Riska researched to development of e-modules based on creative problem-solving (CPS) for chemistry learning. The results showed that e-modules were declared valid with a percentage of 90%, and students responded well to implementing these e-modules in learning [24]. Then, Nurfajriani also researched by implementing CPS-based e-modules on chemical bonding material to increase mastery of 21st-century skills. The study results showed an increase in student mastery of 21st-century skills after using this e-module [25]. Mahmidadatul Fitri also conducts research through the development of learning tools that are integrated with 21st-century skills, the results of the study are that the learning tools meet valid criteria with a score range of 3.43 – 3.52, are very practical with a percentage of 91% for small groups and 92.5% for large group [26]. Based on the description above, the writing team tried to develop an e-module based on the CPS Model in the context of mastering 21st-century skills. The author develops an e-module based on the integrated CPS model of 21st-century skills. The difference with previous research is integrating 21st-century skills in e-modules developed based on the CPS model in learning physics. The combination of the CPS model and 21st-century skills in teaching material is expected to develop students' 21st-century skills. In addition, this e-module is presented according to the steps of the CPS model, which can activate students in critical, creative, communicative, and collaborative thinking (21st-century skills). This e-module is expected to facilitate students to learn independently and can assist students in developing critical thinking skills [22], [27].

Several studies on e-modules have been performed, that include the development of web-based e-modules [23], e-modules based on creative problem-solving (CPS) [24] [25], and learning tools integrated with 21st-century skills [26]. However, research that integrates 21st-century skills based on the CPS model in physics learning has yet to be conducted. As a result, this study aims to fill a gap in relevant research. In contrast to earlier studies that just generated e-modules without integrating 21st-century skills and the CPS model, the novelty of this research is the production of e-modules that present steps to improve 21st-century abilities following the CPS model.

2. METHOD

This research is part of Research and Development using the Reeves Model [28]. This development model consists of the following stages. This research began with a needs analysis that found it necessary to develop e-modules based on the CPS model containing 21st-century skills [29]. Then the CPS model-based e-module design was performed, which contained 21st-century skills consisting of introduction, content, and closing. The content of the e-module was dynamic fluid material. After that, the expert carried out the validity test, resulting in the e-module being very valid [30]. Through the practicality test, information was obtained that the e-module was very practical from the perspective of teachers and students [31].

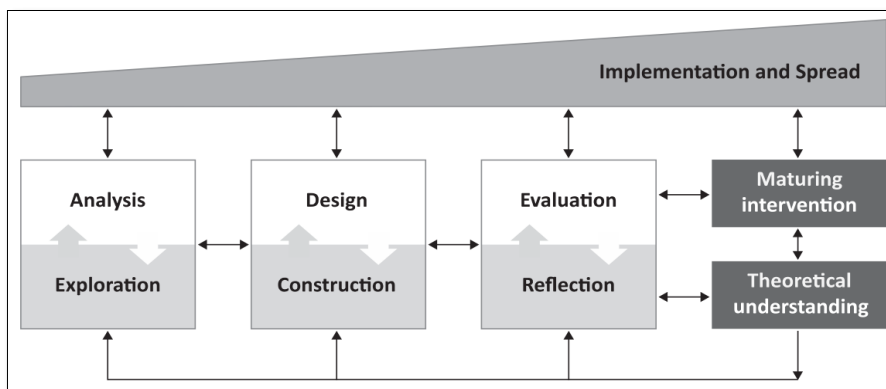


Figure 1. R and D Phase of the Reeves Module [28]

In this paper, the process and results of measuring the effectiveness of the e-module will be described. Measuring the effectiveness of the e-module is part of the evaluation and reflection stages. Data collection techniques were carried out through pretest and posttest tests of students' mastery of 21st-century skills. The researchers tested the effectiveness using the One-Group Pretest (T1) and Posttest (T2) Design.

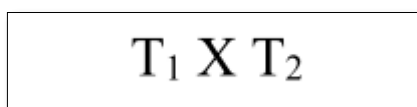


Figure 2. The One Group Pretest (T1)-Posttest (T2) Design

In this design, the researchers first administered a Pretest (T₁) before conducting treatment (X) (learning using an e-module based on the CPS model integrated with 21st-century skills). After conducting the treatment, the researchers administered a Posttest (T₂). The sampling technique used was purposive sampling, namely determining the sample with specific considerations [32]. The sample for this research was the twelfth-grade students of class XII IA 1, SMA Negeri 1 Pesisir Selatan. The data analysis technique used was descriptive statistics and inferential statistics using the t-test by comparing students' mastery of 21st-century skills before learning and after learning using integrated CPS-based e-modules of 21st-century skills.

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad (1)$$

Data analysis was carried out using SPSS.

3. RESULTS AND DISCUSSION

This research is research and development, which includes several steps (analysis, design, and evaluation). The following presents the results of the previous research stages:

- Analysis: The needs analysis results show that an e-module is needed based on the creative problem-solving (CPS) model that contains 21st-century skills [29].
- Design: The e-module was developed based on the CPS model, including century skills [33].

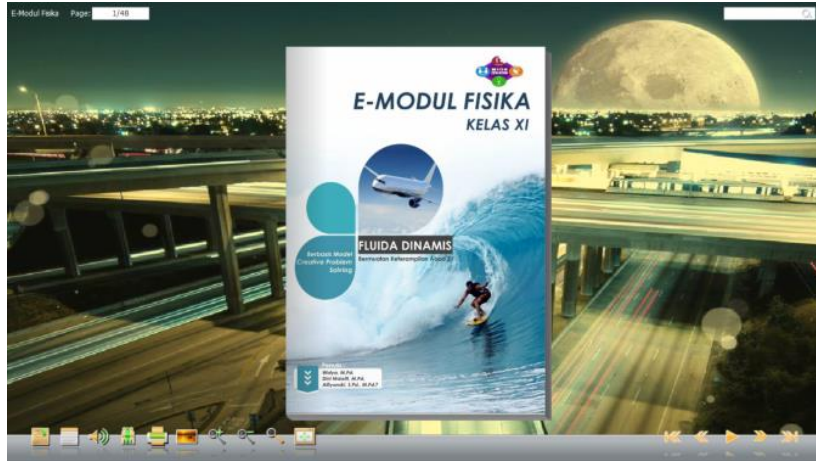


Figure 3. Cover of E-module [33]

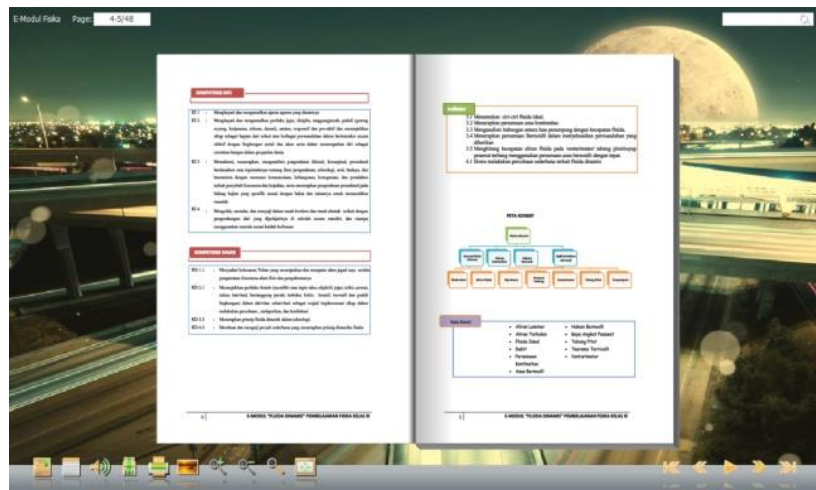


Figure 4. Learning Objectives, Concept Maps, and Keywords [33]

MODUL 1 **KONSEP FLUIDA IDEAL**

EXPLORE THE VISION

Indikator :
3.4.1. Menentukan ciri-ciri fluida ideal.

Tujuan Pembelajaran:
3.4.1.1: Melalui diskusi kelas, peserta didik mampu menjelaskan konsep fluida ideal dengan baik

Video 1: Aliran Dara Manusia (<https://www.youtube.com/watch?v=jRQB4hPw5Dk>)

Figure 5. Title, Learning Objectives, and Video

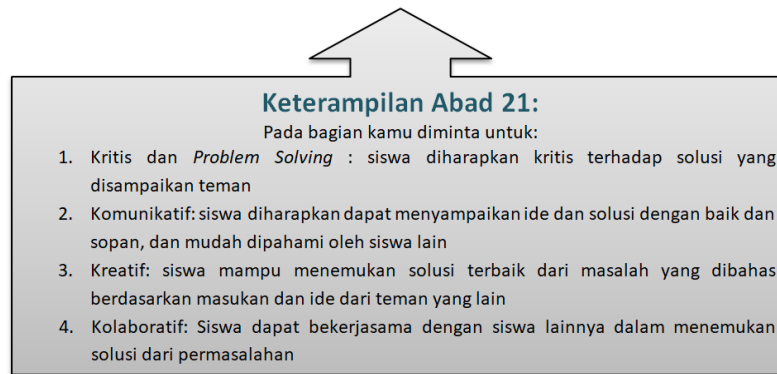


Figure 6. 21st Century Skills on Formulate the Solution Stage

The pictures above are excerpts of the CPS model-based physics e-module containing 21st-century skills [33]. The developed physics e-module contains thermodynamic material. This e-module consists of four e-modules. At each stage of the CPS model, an explanation of 21st-century skills that students can master is given.

- Evaluation through validity, practicality, and effectiveness tests. The physics e-module based on the CPS model, which contains 21st-century skills, meets valid criteria with a score of 83 – 95,45 [30]. Then, this e-module also meets practical criteria with a score range of 80,93 to 89,06 [31].

The effectiveness test is carried out after the validity test and practicality test. The effectiveness test was conducted in class XI- IA 1 SMA Negeri 1 Painan. This stage aims to see the effectiveness of the e-module in improving student mastery of 21st-century skills. By comparing the mastery of 21st-century skills and mastery of 21st-century skills before and after using the e-module, we can determine the effectiveness of the CPS model-based physics e-module integrated with 21st-century skills.

The following presents a comparison of student mastery of 21st-century skills before and after using the e-module

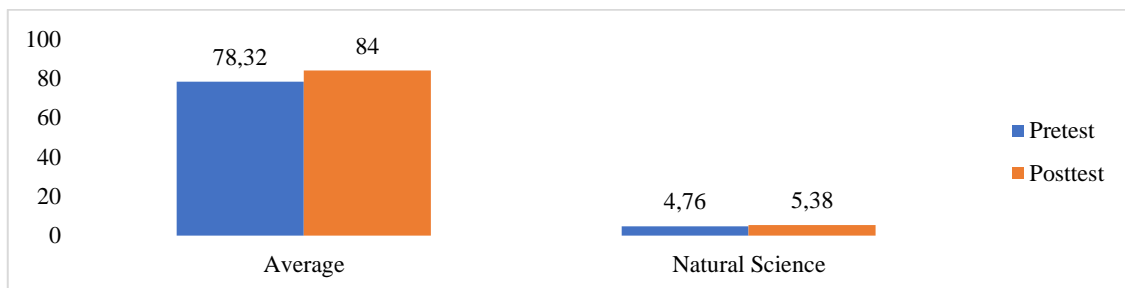


Figure 7. Comparison of Pretest and Posttest Results

Based on the picture above, information is obtained that there is an increase in the average mastery of 21st-century skills obtained by students from 78,32 to 84. indicates that the physics e-module based on the CPS model can improve student mastery of 21st-century skills. The increase in mastery of 21st-century skills also shows an increase in mastery of 21st-century skills by students.

Next, a hypothesis test is carried out regarding the effect of using the physics e-module based on the CPS model integrated with 21st-century skills in learning through the following hypothesis:

Ho: there is no difference in student mastery of 21st-century skills before and after using the CPS-based physics e-module

H1: there are differences in student mastery of 21st-century skills before and after using the CPS-based physics e-module

Hypothesis testing was carried out by giving students a pretest (before using the CPS model-based physics e-module) and a posttest (after utilizing the physics e-module). The pretest and posttest questions were developed from the same grid, so they have the same difficulty level. In addition, the questions used also measure students' mastery of 21st-century skills.

Hypothesis testing was carried out using the SPSS application by comparing the pretest and posttest results. The results of hypothesis testing can be seen in the following Figure.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PRETEST - POSTEST	-5.67647	5.15058	.88332	-7.47359	-3.87935	-6.426	33	.000

Figure 8. Hypothesis Test Results (Average Test)

Based on the picture above, information is obtained that the value of Sig (2-tailed) <0.05, then H1 is accepted, meaning that there are differences in student mastery of 21st-century skills before and after using the CPS-based physics e-module. Based on the tests conducted above, the e-module with the integrated CPS model of 21st-century skills is effectively used in learning.

These results are consistent with Vina Serevina's research which states that using e-modules can improve student mastery of 21st-century skills, especially science process skills [34]. Learning with e-modules can make it easier for students to learn, interactive, practical, and can be accessed anywhere [35]. Learning with e-modules is very popular with students because it contains videos, animations, audio, text, and others [36].

Student interest in learning using this e-module has led to an increase in student mastery of 21st-century skills. Then, integrating 21st-century characters in learning has also impacted students' mastery of 21st-century skills. 21st-century skills need to be introduced to students to be able to compete globally in the future [37]. The development of e-modules based on the CPS model has activated students' thinking. The increase in student mastery of 21st-century skills [15]. The CPS model can start students to think critically, increase creativity in solving problems, students can collaborate with friends in solving problems and can communicate solutions to friends [15]. Thus, the CPS model can improve students' mastery of 21st-century skills.

Mastery of 21st-century skills by students because each stage of 21st-century skills is integrated with each stage of the Creative Problem-solving (CPS) model.

- Explore the Vision stage aims to explain the learning objectives in each module. Developed 21st-century skills are critical. Students are expected to be critical in questioning learning purposes and preparing themselves for learning to achieve the goals set.
- Gather Data; students are asked to collect data by collecting phenomena related to the studied material. The 21st-century skills developed at this stage are critical in seeing the connection between phenomena and the studied material.

- In the formula challenge stage, students are asked to formulate the problems found in the previous stage in groups. At this stage, students are facilitated to develop creativity in preparing issues, working with teams in formulating problems and being critical of problems formulated by group mates. In addition, this stage also facilitates students to develop communication skills in conveying the problems formulated.
- At the Explore Idea stage, each module displays material related to the problems given and becomes material for student consideration in choosing the solutions provided. At this stage, students are facilitated to develop problem-solving skills, be critical of the information presented, and be creative in choosing information to become alternative solutions to the problems formulated.
- At the Formula Solution stage, students are asked to discuss with group mates to find solutions to problem-solving. The 21st-century skills developed at this stage are critical of alternative solutions provided by group members, creative in formulating alternative solutions, communicative in conveying ideas and working well with group mates in selecting solutions from various alternative solutions.
- At the Implement Formula stage, one of the groups presented a solution to the problem, then discussed it in class, and the best solution was decided. The 21st-century skills developed at this stage are communicative in conveying ideas to classmates, critical of ideas/solutions given by other groups, and working with all classmates and teachers in formulating conclusions.

Integrating 21st-century skills in each stage of CPS in the e-module impacted improving students' 21st-century skills.

Researchers have tested the validity, practicality, and effectiveness of the CPS-based physics e-module integrated with 21st-century skills. However, this e-module was explicitly developed for dynamic fluid material (physics learning). The following research plan is to establish e-modules for other physics materials. This e-module product can be an example of developing physics e-modules in other physics learning materials. The availability of physics e-modules for all physics materials is expected to accelerate the improvement of students' 21st-century skills.

4. CONCLUSION

The physics e-module based on the CPS model and integrated 21st-century skills meets the criteria of being effective. It can be seen in the increase in student mastery of 21st-century skills from 78,32 (pretest) to 84 posttests. Then, based on hypothesis testing, information was obtained that there were differences in student mastery of 21st-century skills before and after using the CPS-based physics e-module (Sig (2-tailed) < 0,05). It indicates the effect of using e-modules based on the CPS model integrated with 21st-century skills to effectively increase student mastery of 21st-century skills and mastery of 21st-century skills. The next stage of this research is to disseminate the physics e-module based on the CPS model integrated with 21st-century skills to a larger group (districts/cities and provinces) and try to design e-modules for other physics materials.

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