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Development of Science E-Module Based on Case Method to Improve Students' Problem Solving Skills

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Abstract

Life in the 21st century is full of challenges and problems that need to be solved in order to survive in global competition. This condition makes science education in the 21st century must be able to produce graduates who are not only good at knowledge, but also have critical thinking skills, creativity, collaboration, communication, not to mention problem solving. The purpose of this study was to analyze the effectiveness of e-modules based on case methods to improve the problem solving skills of prospective science teachers. This research uses RnD with the ADDIE model. Then e-module based on case methods that has been developed is implemented in basic science learning with a quasi-experimental design Non-equivalent control group design. Data analysis was conducted with the validity, characteristics, and effectiveness of e-modules based on case methods. The results showed that the e-module based on case methods was valid for use with a value of 0.98. The implementation of e-modules showed an increase in pretest and posttest results with an experimental class n-gain score of 0.85 with high criteria, while the control class n-gain score was 0.68 with moderate criteria. The conclusion of this study is that the e-module based on case methods is effectively used to improve the problem solving skills of prospective teacher students in Basic Science courses.

How to Cite

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INTRODUCTION

Living in 21st century is full of challenges and problems that need to be solved in order to survive in global competition (Asri et al., 2023). This condition leads education in the 21st century must be able to provide graduates that are not only good at the knowledge, but also have critical thinking, creativity, collaboration, communication and problem-solving skills. On higher education, this is crucial because students are expected to be professionals that is able to adapt in the future, especially science major students (Sinaga et al., 2024). As a future educator, science major students need to master science in depth for transfering knowledge in teaching, so that the knowledge can be understood fully and can be applied in daily life. Basic science for science major students is one of the foundation that plays important role in understanding and applying the basic concept of science (Winarto et al., 2019). However, the approach that is commonly used is teacher center learning, which lacks in engaging the students attention in understanding the basic concepts of science and lack in developing the 21st century skills. One of the innovative solutions is to make development in e-module based on case method become relevant and applicable.

E-module (electronic module) is a digital module that consists of text, image, audio, video, and animation that also comes with formative quiz as well as real time feedback to support the learning process. E-module implementation in science major has done before and give positive results such as improving the higher order thinking skills (Firmansyah et al., 2023); increasing student's score (Lestari et al., 2024); understanding the concept better (Faridah & Afridiani, 2021); engaging the stundent's motivation and interactive learning (Al Jarwi et al., 2024); developing the 21st century skills (Ainy & Ahmad, 2024). The use of e-modul in the learning process is considered to be more effective rather than printed module. E-module can be optimized to improve the problem solving skills that recently important for scince major students. Zahara (2023) stated that e-module based on case method can be used to improve stundent's problem solving skills. Case method has the opportunity to learn and solve problems that relevant in daily life. Not only focus on the cognitive development, e-module based on case methods, but also honing problem solving skills in a creative way such as identifying the problem, evaluating the data, and developing solution (Ilhami, 2023).

Based on observation that held by science education major in UNNES, it is known that the application of e-module is not yet to be found in basic science class. The research aims to increase the basic science concept that is important to the students skills and understanding. This observation results is supported by the value from the questionaire that majority of it (53.1 %) shows that the students struggled to understand the basic science. However 21.9 % shows that the students felt significant difficulties. These numbers indicate that many students need more learning resources to support their understanding of basic science concepts better, because they are prepared to be future educators. The previous studies that had been done showed that urgency of this research. Therefore, this research goal is for developing and knowing the effectiveness of e-module based on case method for improving the students problem solving skills.

M ETHOD

This research use the RnD (Research and Development) with ADDIE as the procedure to develop product. ADDIE consists of 5 steps, they are Analysis, Design, Development, Implementation, and evaluation (Branch, 2009).

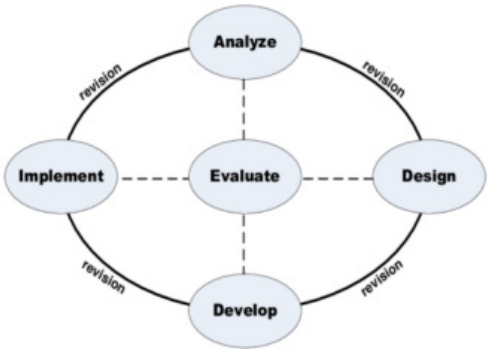

Figure 1. The step of RnD with ADDIE as the approach

This research started by analysing the need of e-module to improve students problem solving skills. The next step is designing product which is e-module and developing it based on the need. Validity test is important to check the e-module quality. Then e-module is implemented to students for assesing the improvement of students problem solving skills. The evaluation is needed for every steps to make sure the product is suitable for the use.

The implementation of e-modules in this study used Quasi Exsperimental Design with Nonequivalent control group design. Pretest was used to determine students' problem solving

skills. The experimental class applied e-modules based on the case method, while the control class used conventional learning resources such as powerpoint. After the learning process, posttest was conducted on both classes and problem solving analysis based on the test. The research design is shown in Table 1.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experimental (E)	O_1	X	O_2
Control (C)	O_1	Y	O_2

Description:
X : E-modul based on case method
Y : Conventional learning resource (Powerpoint)

Research data analysis was conducted to determine the validity and effectiveness of e-module based on case method products developed to improve problem solving skills. The validity test was conducted by five experts consisting of two lecturers and three science teachers to measure the validity level of the e-module material and media. The validity test results were analyzed using Aiken V with the following formula.

$$V = \sum S/[n(c-1)]$$

s = r - lo
lo = The lowest validity assessment score
c = The highest validity assessment score
r = The number given by an expert

Data analysis was also carried out to measure the effectiveness of e-modules based on case method to improve problem solving skills. This analysis is based on the results of pretest and posttest in the control class and experimental class. effectiveness test using the N-gain formula as follows.

$$\langle \text{N-gain} \rangle = \frac{Spost - Spre}{Smax - Spre}$$

Explanation:
<N-gain> = Improvement of Science Literacy Values
S_{pre} = Pre-test Score
S_{post} = Post-test Score
S_{max} = Maximum Score

The level of problem solving skills can be seen in Table 2.

Table 2. Level of Problem Solving Skill

Score	Criteria
$0.7 \leq g \leq 1$	High
0.3 g 0.7	Moderate
0< g 0.3	Low

RESULT AND DISCUSSION

E-module is interactive teaching materials, making it easier for learners to move between sections supported by elements such as tables, videos, images, and also formative exercises (Widiastuti, 2021). The utilization of electronic modules can significantly improve memory, level of understanding, and skills (Hidayati, et al., 2023). E-modules aid explanation, make the subject matter comprehensible and increase learners' motivation during the learning process (Oktaviani & Tari, 2018). E-modules can also foster learning independence so that self-confidence, motivation, initiative, discipline, and responsibility grow which can have an impact on students' critical thinking skills (Humairah & Wahyuni, 2024). This e-module was developed with case methods to provide contextual learning experiences through the presentation of real problems relevant to students' daily lives related to basic science concepts.

The developed e-module was tested for validity before being implemented. Data on the validity of e-module based on case methods was obtained from the results of validation by media expert validators and material expert validators consisting of 2 lecturers and 3 science teachers. Validation aims to determine the feasibility of e-module based on case methods before being used in product implementation. e-module based on case methods is said to be valid if the validity value of the e-module obtained is > 0.87 with an error scale of 5% or P < 0.05 from media experts and material experts. The media aspects of the e-module based on case methods validated by media experts consist of aspects of general appearance and presentation aspects, while the material aspects of the e-module based on case methods validated by material experts consist of aspects of material coverage and case studies. The results of media and material validation by media experts on e-module based on case methods are presented in Table 3.

Table 3. Validity of E-module Based on Case Method

No	Aspects	Validity	Criteria
1	General view	0.96	Valid
2	Presentation	1.00	Valid
3	Scope material	0.98	Valid
4	Case method	0.98	Valid

Based on the test results by 5 media and material experts, the value is 0.98 with valid criteria.

e-module based on cased methods can be used as a medium in the Basic Science learning process to improve the problem solving skills of prospective teacher students. This implementation stage involves 2 classes, namely the experimental class and the control class. Each class conducted a pretest to measure the problem solving skills of prospective teacher students before learning. At the end of the learning process, a posttest was conducted to measure the significance of changes in the problem solving skills of prospective teacher students. The data collected from the pretest and posttest were analyzed using N-gain to determine the effectiveness of e-module based on cased methods in improving problem solving skills. The results of the N-gain score analysis can be seen in Table 4.

Table 4. N-Gain Results

Variabel	Pretest	Posttest	N-Gain	Criteria
Control	54.39	85.52	0.68	moderate
Experiment	52.58	92.67	0.85	High

Based on the results of data analysis in Table 3, it can be seen that there is a difference in N-Gain values between the experimental class and the control class in learning basic science courses. The control class that used power point without case study-based e-modules obtained an N-Gain of 0.68 with a medium category, while the experimental class that used case study-based e-modules showed a higher N-Gain, which was 0.85 with a high category. This difference indicates that the use of case study-based e-modules is able to improve the problem-solving skills of prospective science teachers with a level of effectiveness in the high category.

The development of e-modules based on case methods is adjusted to the Graduate Learning Outcomes of Basic Science Courses. The results of e-module characteristics based on case methods are obtained from the validity test results (analysis of media validation questionnaire sheets by media experts and material validation questionnaire sheets by material experts). The test results are an indicator that the e-module based on case methods meets the characteristics of e-modules according to Ministry of Education (2017) which include, (1) self instructional, (2) self contained, (3) stand alone, (4) adaptive, (5) user friendly, (6) consistent in the use of letters, spaces and layouts, (7) electronic based, (8) utilizing media functions, (9) utilizing various features, and (10) interesting.

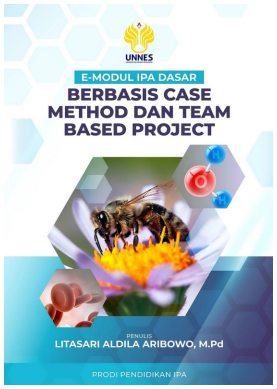

Figure 2. Display of e-modules based on case methods

E-modules based on case methods have self instructional characteristics, namely e-modules can provide opportunities for students to learn independently and not depend on other parties. The characteristics of self instructional on e-module based on case methods are indicated by the existence of Graduate Learning Outcomes on Basic Science material. This e-module is also equipped with case study implementation instructions on the e-module so that it fulfills one of the characteristics, namely user friendly. The characteristics of self instructional on e-module based on case methods are presented in Figure 3.

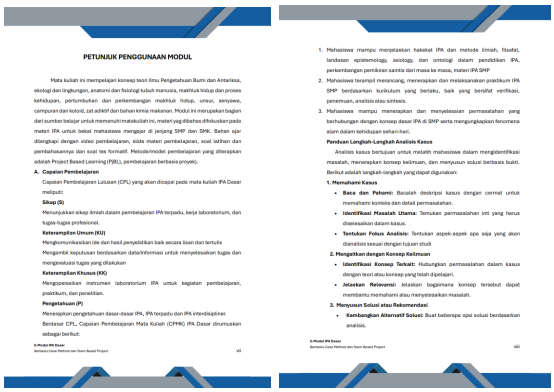

Figure 3. Characteristics of self instructional and user friendly on case method based e-modules Characteristics of self instructional and user friendly on case method based e-modules

E-module based on case methods has self contained characteristics, namely the entire material taught from one learning outcome studied is contained in one module as a whole. In this e-module there are descriptions of materials related to Basic Science systematically and completely. Furthermore, after understanding the material, case studies are presented that need to be completed by students according to the material that

has been studied. The self contained characteristics of the E-module based on case methods are presented in Figure 4.

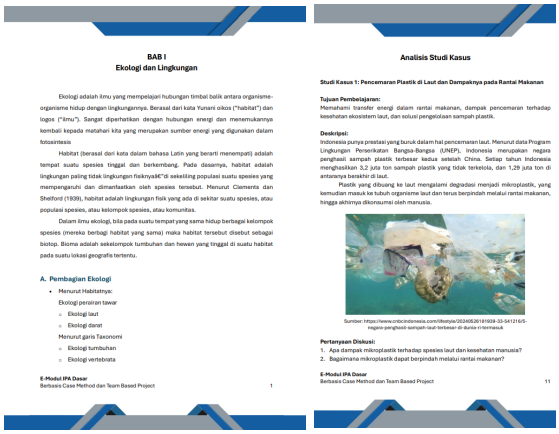

Figure 4. Characteristics of self contained on e-module based on case methods

E-module based on case methods has stand alone characteristics, namely the emodule is presented completely so that its use does not depend on other teaching materials or media. In addition, E-module based on case methods has electronic-based characteristics that can be accessed through electronic devices so that it can be opened anytime and anywhere practically. E-modules based on case methods are also developed by utilizing several media functions and various electronic features such as videos and links linked in the e-module. The links present images, learning videos, and various other supporting media in the learning process.

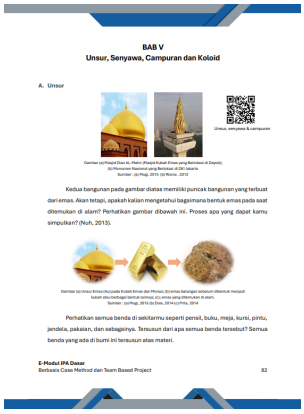

Figure 5. E-module as electronic-based learning media

E-module based on case methods has adaptive characteristics, that is, the e-module has adaptive power to the development of science and technology. E-module based on case methods is an electronic module that adopts the PjBL (Project Based Learning) learning model. This helps prospective science teacher students in practicing problem solving skills in Basic Science material. The application of the PjBL model also shows that this e-module adapts to the development of science and technology, is flexible in use, and up to date. Through case study activities and making projects, students train their ability to think critically about problems that occur and make innovative solutions in the form of group projects. This also makes the E-module based on case methods an interesting learning resource for students to use during the learning process of Basic Science materials. The adaptive and interesting characteristics of the e-module based on case methods can be seen in Figure 6.

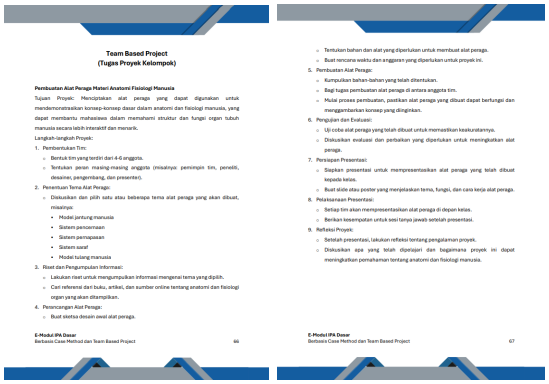

Figure 6. Adaptive and interesting characteristics of e-module based on case methods

Science is closely related to life because it studies various natural phenomena and scientific principles that underlie all events around (Permana, et al., 2021). By understanding science, individuals can recognize the relationship between humans and the environment, and make wise decisions in facing various challenges and problems (Herdiana, et al., 2021). This makes it necessary for prospective science teachers to have problem solving skills as an important provision in carrying out their professional roles in the future (Wulandari, et al., 2022). In the context of science education, teachers not only function as material deliverers, but also as facilitators who help students develop scientific thinking and higher order thinking skills. Problem solving skills allow prospective teachers to analyze complex learning situations, design effective teaching strategies, and adjust learning approaches according to the science material being taught as well as the needs and characteristics of students (Susanto & Susanta, 2022). Problem solving skills also enable prospective science teachers to provide concrete examples to students of how to apply the scienti-

fic method to solve real problems so that learning becomes more relevant and meaningful (Hadi, et al., 2019). In the implementation of 21st century learning, problem solving skills are the main skills that prospective science teachers need to master to create educational success (Ritonga, et al., 2020; Juniartina & Erlina, 2024).

Students have higher problem solving skills after using e-modules with case studies compared to learning using PowerPoint (PPT) in science learning due to the fundamental differences in approach, depth of student engagement, and interactivity offered. E-module based on case method are designed based on constructivist approach, where students actively construct their knowledge through real problem exploration, data collection, analysis and reflection. In the e-module, students are exposed to complex situations that require them to identify problems, connect relevant science concepts, and evaluate various alternative solutions based on scientific evidence (Azizah, et al., 2022). This process involves higher-order thinking steps such as analysis, synthesis and evaluation, which are the core of problem-solving skills (Agung, et al., 2022).

In contrast, learning using PPT tends to be a one-way lecture and focuses more on delivering information in a linear fashion. PPT usually not designed to encourage students' independent exploration or divergent thinking. While they can be helpful in visually clarifying material, they do not actively engage students in critical thinking processes or context-based decision-making (Sartika, et al., 2020). By using case method in e-modules, students also practice working collaboratively or individually in solving open-ended problems, where there is not always one right answer, so they are encouraged to construct logical arguments, test hypotheses, and consider the consequences of each choice (Kusumasari, et al., 2022). This process strengthens their ability to tackle real challenges, which goes far beyond the skills honed through PPT-based learning (Hafizah & An'nur, 2018). Therefore, e-module based on case methods are superior in developing problem-solving skills as they integrate content, context, and active learning strategies holistically.

CONCLUSION

The implementation of e-modules showed an increase in pretest and posttest results with an experimental class n-gain score of 0.85 with high criteria, while the control class n-gain score was 0.68 with moderate criteria. Based on the results of the study, it can be concluded that the e-module based on case method is effective to improving the problem solving skills of prospective science teachers in basic science courses.

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