6 (2) (2021) 91-99

International Journal of Active Learning

http://journal.unnes.ac.id/nju/index.php/ijal

The Critical Problem Solving (CPS) E-Module Development on Ethnoscience-Integrated Thermochemistry Topics

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Article Info

Keywords:
E-Module, Critical Problem Solving, Ethnoscience

Abstract

Critical thinking and problem-solving skills (CPS) are included in the 21st-century competencies that are emphasized in K13. However, this ability is still low because there is less emphasis on learning. One of the devices that can be used as a means to train students in both cases is through e-modules. CPS provided through e-modules is more meaningful if it integrates material with ethnoscience. In this study, an e-module has been developed through the R&D method which aims to provide students' CPS skills. The feasibility value of the e-module is 88.26% (material expert) and 92.14 (media expert), while the practicality value is 77.95%. Based on the results of data analysis, it can be concluded that the e-module which developed feasible and practical to use.

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p-ISSN 2528-505X
e-ISSN 2615-6377

INTRODUCTION

The implementation of the 2013 curriculum (K13) aims to produce students who are productive, creative, innovative, and effective through strengthening attitudes, skills, and knowledge. The implementation of this curriculum emphasizes strengthening the learning process, namely: 1) 21st-century competency framework; 2) a learning process that supports creativity, and 3) process strengthening steps (Uce, 2016). The strengthening of the learning process carried out can encourage students to get used to observing and asking what they have learned after studying at school (Jauhari et al., 2017). Learning K13 also uses a scientific approach with 5M syntax. The implementation of this approach includes observing, asking questions, gathering information, associating, and communicating (Trisnawati et al., 2016). Students who are directed with such learning will be trained to be sensitive to problems that occur in the surrounding environment (Machali, 2014).

One of the 21st-century competency frameworks that are emphasized in K13 includes students' thinking abilities. The use of a scientific approach requires students to be able to develop their thinking skills to be sensitive to problems and solve them. Problem-solving and critical thinking refers to the ability to use knowledge, facts, and data to solve problems effectively. Students must be able to think, assess problems, and find solutions.

One of the abilities expected from 21st-century competencies can be achieved by active learning. Active learning strategies promote the growth of creativity, independence, cooperation, solidarity, and tolerance. However, 21st-century skills are less visible even though learning takes place actively such as debate and discussion in class (Schleicher, 2012). These results indicate the need for learning that can develop critical thinking skills, creativity, as well as communication and collaboration skills. Etherington (2011) argues that in addition to constructivism learning, problem-based learning will make students active in the learning process.

This learning can be supported by the procurement of relevant and supportive teaching materials. The content and context in teaching materials need to be thought out carefully so that it leads to the provision of students' thinking skills. PISA in supporting the learning process has a special framework that regulates scientific competency references, variations in context coverage, the nature of the knowledge contained in the questions, and the basis of scientific attitudes (OECD, 2017). Scientific literacy which is the framework in PISA is made so that all students understand science and science-based technology to make various decisions related to the social and natural spheres in their daily lives (Agustiani, 2020). The ability to make various decisions is the result of the process of providing critical thinking skills and problem-solving in the context of critical problem-solving.

The field study results show that there are still some obstacles in the implementation of the learning process. In general, learning is done by emphasizing understanding the concept and then being tested with practice questions in the textbook. The results of the analysis of textbooks used in various schools do not all contain CPS indicators. Several books embed critical thinking indicators, but they are limited to one indicator. In addition, the teaching materials used have not integrated the material with the concept of ethnoscience. CPS learning will be more meaningful if it is integrated and raises ethnoscience, which is generally the knowledge of people's perceptions of certain natural phenomena and is related to the community's original knowledge (Sudarmin, 2014). Lia (2016) stated that the integration of original science concepts into school science learning can give a scientific rationale touch to these original concepts. That way what students learn can be accepted logically.

The original knowledge of the community in the surrounding environment can be integrated into the chemistry learning process. Baskoro & Rosdiana (2018) explained that one of the factors that can increase enthusiasm for learning is environmental factors. The local environment can be used as a learning medium.

The original scientific values of a society can be studied and analyzed and then transformed into scientific science. The process of inculturation or strengthening pre-existing cultural values can also occur through ethnoscience (Sudarmin et al., 2017). One of the local-wisdom that exists in the community, especially Semarang, is the manufacture of smoked fish as an ingredient for making mangut fish culinary. In the process of making smoked fish, there are several processes related to the concept of thermochemistry.

During the pandemic, the learning process is carried out online. Students are required to be able to access various information and learning resources to better understand the material presented by the teacher online. Advances in technology and information now make it easier for students to access electronic teaching materials. The electronic module (e-module) is a teaching material that is quite suitable for the current situation. E-modules allow students to be able to learn independently and actively because the teacher is a facilitator and has advantages over print modules (Setiarini et al., 2016). E-modules do not only contain material or textual descriptions, audio, moving images, or videos can be inserted to support concept mastery. content e-module Diverse and interactive makes students more active in learning (Liana et al., 2019).

Based on the problems above, we need a learning resource in the form of e-modules to facilitate students in learning. The development of e-modules can be applied by providing critical thinking content to solve problems and the material discussed is integrated with ethnoscience. The e-module developed is on thermochemistry topics. This material is closely related to the phenomena of everyday life related to energy and heat. The adoption of smoked fish local wisdom in chemistry learning can stimulate students to apply the scientific concepts learned in their daily lives. This study aims to develop an e-module containing CPS with integrated ethnoscience material, analyze the feasibility and analyze the practicality of e-module the developed.

METHOD

The method used in this research is Research and Development (R&D) with a 4D model from Thiagarajan which is reduced to 3D. The development of e-modules in this study was only carried out until the stage of development. This research was conducted in MAN 1 Semarang Regency. The research subjects were 53 students with 15 students as small-scale test subjects and 38 students as large-scale test subjects.

Data collection methods used include observation, interviews, questionnaires, tests, and documentation. This study contains data analysis such as analysis of the characteristics of e-modules, the feasibility of e-modules from expert validation, teacher and student responses, and the practicality of using e-modules.

RESULTS AND DISCUSSION

The preparation of the e-module is based on critical thinking and problem-solving skills that are important for students to have. Therefore, e-modules are made by embedding critical thinking indicators and problem-solving indicators. This is done so that students are familiar with coherent thinking processes and can analyze things with their knowledge to solve problems. The e-module is also integrated with ethnoscience. This ethnoscience helps students to learn chemistry, especially thermochemistry, from the culture of the society where they live. Ethnoscience taken in this study is the process of smoking fish. Through the process of smoking fish, students are expected to be able to analyze any thermochemical concepts that occur. This e-module containing ethnoscience integrated CPS is designed to be divided into 4 parts, namely introduction, introduction, content, and closing.

The introductory section of this module provides an overview of what is presented in the module. The contents of this section include the introduction, characteristics of the e-module, table of contents, list of pictures, and strategies for problem-solving. The preface contains gratitude and thanks for making the e-module.

Characteristics of the e-module contain content that characterizes this module. The content includes strategies problem solving, web exploration, ethnoscience info, sample questions containing strategies problem solving, discussion boxes (as a place for students to discuss in groups), and brain teasers (strengthening students' understanding). The table of contents and the list of images contain what content is discussed in the module and what images are presented. The strategy problem solving contains steps to solve the problem according to the recommended order of indicators. These steps are to understand the problem, plan a solution, carry out the solution plan that is made, and re-examine the results (Chang et al., 2017; Chen & Kuo, 2019).strategies are Problem-solving presented to train students to get used to collect data and information needed to solve a problem, planning and implementing and evaluating actions, using social networks, and exchanging knowledge and information with others through communication (Buchwald et al., 2015). This is supported by the opinion of Lee & Lee (2020) that problem-solving skills are cognitive, emotional, and behavioral abilities needed to identify problems and engage in the process of finding solutions. This is also relevant to the research of Sulistiyanti et al (2021) that the module containing the steps in solving problems in learning received a positive and interesting response.

The introductory part of the module contains the background, brief description of the material, learning objectives, concept map, and instructions for using the module. The background is presented to give students an idea of what is to be conveyed through this module. A brief description of the material provides information on what subject students will study and the sources of material they will use to study. The learning objectives contain basic competencies (KD) and competency achievement indicators (IPK) from the thermochemistry topics that students will learn. The existence of learning objectives informs students what activities they will do and what subjects they must master in thermochemistry topics. Concept maps are made so that students can more easily see the description of the subject matter in thermochemistry. In the introductory section, instructions for the use of e-modules are also provided so that it is easier for students to learn and students can use the features to the fullest.

The Contents section contains learning activities which in this study are divided into learning activities I and learning activities II. Learning activities contain indicators of learning success, material descriptions, student worksheets, summaries, evaluation of learning activities, as well as feedback and follow-up. Each learning activity contains sample questions, web exploration, ethnoscience info, and discussion boxes. The existence of this content is in line with the research of Suarsana and Mahayukti (2013) that e-modules involve displaying images, audio, video, and animation. Overall the content in the e-module helps students to learn actively and independently. The information presented is accompanied by pictures and videos related to ethnoscience, so that students can find thermochemical concepts in the local wisdom presented. This is in line with research Laksana and Wawe (2015) which states that the use of local culture-based learning media can increase learning activities accompanied by strengthening understanding of concepts. At the end of learning, students are given evaluation questions that can be opened using a QR code or click the question button The questions given are made according to critical thinking indicators so that students not only have to answer correctly but also have to give reasons. The content section also contains feedback and follow-up so that students can conduct a self-assessment of the results of the evaluation questions.

The final part of the e-module is the closing section consisting of bibliography and an answer key. The bibliography contains the references used in compiling the e-module. The answer key is made so that students can check their answers after working on the evaluation questions. Answers that have been checked and then assessed by themselves guide in the

feedback section. From these results, students can determine whether they have understood the material in the related learning activities or not. If their score is less than the specified standard, they must repeat the material before moving on to the next learning activity. The e-module is made by containing the characteristics of CPS to equip students' critical thinking skills. Critical thinking skills can develop through material content that tends to be described in problems that students find in everyday life (Emily, 2011). These characteristics include strategies problem solving, critical thinking content, and content Critical Problem Solving (CPS).

The process of compiling the e-module according to the above draft was carried out using MS Word and then realized into an e-module using Flipbook Corporation software. The-e-module CPS loaded with ethnoscience-integrated thermochemistry material was created to equip students' critical thinking skills. E-modules are tested for validity before being applied in classroom learning (Sugiyono, 2019). The validity of the e-module was tested by providing a validity test instrument in the form of a questionnaire sheet to the material expert validator and media expert. The validators selected consisted of 2 chemistry education lecturers and 1 high school chemistry teacher. The results of the material expert validation are presented in Table 1.

Table 1. Material Expert Validation Results

	Aspect	Percent	Criteria
Material Expert 1	Content	83.33%	Very Feasible
	Presentation	100%	Very Feasible
	Language	75%	Feasible
Material Expert 2	Content	100%	Very Feasible
	Presentation	90%	Very Feasible
	Language	81.25%	Very Feasible
Average		88.26%	Very Feasible

The material expert validation assessment based on Table 1 shows that e-module developed as a very feasible category. Both material experts have the same view regarding the language aspect in the module. This can be seen from the score of the language aspect which has the lowest value among other aspects. Nevertheless, the e-module the developed is feasible to use in learning. Improvements were made more in the spelling section, namely correcting some misspelled words and sentences as well as making improvements to some apperceptions.

After all the improvements are made, the e-module is ready to be tested in learning. Based on material experts, the module is feasible to use, while the results of media expert validation are presented in Table 2.

Table 2. Media Expert Validation Results

	Aspect	Percent	Criteria
Media Expert 1	Ease of Use Appropriate	85%	Very Feasible
	Software	83.33%	Very Feasible
	Consistency	93.75%	Very Feasible
	Graphics	81.25%	Very Feasible
Media Expert 2	Ease of Use Appropriate	100%	Very Feasible
	Software	100%	Very Feasible

	Consistency	100%	Very Feasible
	Graphics	93.75%	Very Feasible
Average		92.14%	Very Feasible

Data from media expert validation in Table 2 shows that the e-module developed is in the very feasible category to use. These results are obtained on the condition that there is a need for improvement in several ways. Improvements made are to pay attention to the consistency of the display on gadgets differently. In addition, for the convenience of users when opening e-modules using gadgets, the paper size has been changed from A4 to A5. This step is done so that users do not need to zoom in or out on the layer when reading the content in the module. Another improvement made is to clarify the formula and important things by giving a contrasting color or giving squares and circles to the formula. In addition, images and symbols that are not related or as decoration are removed to make the module page more comfortable to look at. Improvements were made according to the validator's suggestions, making the e-module feasible to be tested in learning.

The first trial conducted was a small-scale trial by distributing e-module to 15 students of class XI MIPA. E-module is used as a learning resource in a classroom during the discussion of thermochemistry topics. After learning is complete, students are given a questionnaire sheet to respond to the use of the module and assess its practicality when used. Student responses are used to support the feasibility of the e-module if it is used as a learning resource. After the small-scale trial was completed, it was followed by a large-scale trial of 38 students of class XI MIPA. The recapitulation of the results of student responses on small and large- scale tests is presented in Figure 1.

Description of Assessment Aspects: Learning, Contents, Display, Legibility

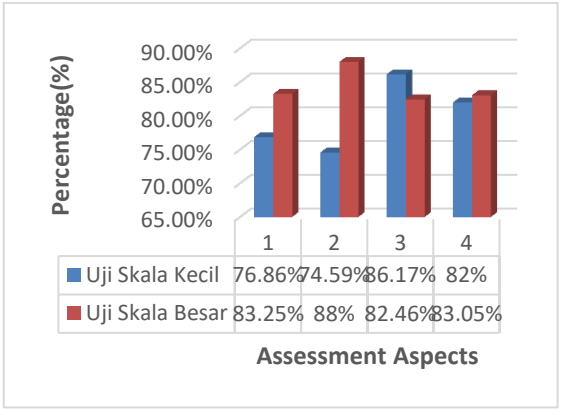

Figure 1. Recapitulation of Student Responses to E-Modules on Small-Scale Test and Large-Scale Test

Student responses to e-modules based on the data in Figure 1 as a whole show a good response. The average score of the assessment aspect e-module is 79.9%, which means that the e-module is feasible to be used as a learning resource. However, the good responses given by students are still accompanied by input and suggestions for improving the e-module. The inputs and suggestions include the images presented need to be enlarged and clarified again, it is necessary to add a discussion of examples and practice questions in the form of videos, and it is necessary to correct some sentence structures that are still typos The inputs and suggestions are given are used to improve the e-module which is then used in large-scale trials.

Student responses on the large-scale test as a whole showed good results in the very good category. The average student response score is 84.19% which is in the very good category so that the e-module according to student responses is very feasible to use. The score shows an increase compared to the student response scores on the small-scale test. However, in this large-scale test, there were suggestions from students that the e-module be added with a download feature. This feature needs to be made so that students can keep the open e-module even though the signal is in bad condition. In addition to measuring student responses in the use of e-modules, the small and large-scale tests also

measured the practicality of the e-modules when used. A recapitulation of the practicality of e-modules on small and large-scale tests is presented in Figure 2.

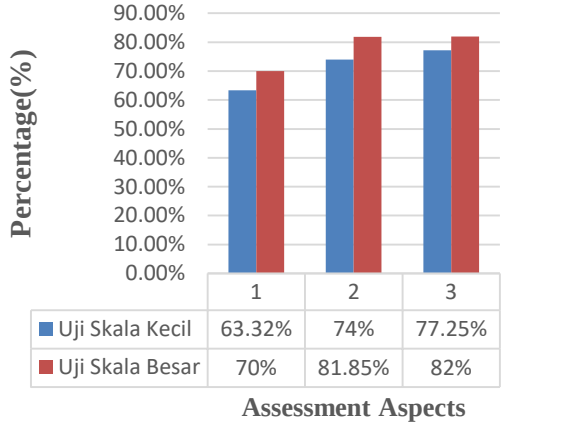

Figure 2. Recapitulation of Practicality of E-Modules on Small-Scale Test and Large-Scale Test

Description of Assessment Aspects: 1. Ease of Use 2. Learning Time Efficiency; 3. Benefits

The data in the figure shows that the e-module in terms of ease of use, learning time efficiency, and benefits is in a good category. The average score of the three aspects of practicality assessment is 71.53%, which means that e-modules are practical for use in learning. In the small-scale test, suggestions for practicality were obtained from students that the link e-module should be made shorter so that it is easy to remember. The improvement of the e-module from the small-scale test is then used for the large-scale test.

The results of the practicality of the large-scale test show that the practicality of the e-module is increased compared to the small-scale test in each aspect. The average score of practicality e-module is 77.95% which is in the practical category. Therefore, it can be said e-module that the developed is practically used in learning. Overall, students gave a positive response to e-module the developed. These responses include the following:

The e-module containing CPS for ethnoscience-integrated thermochemistry topics is interesting because it is associated with local wisdom. This is under the research of Rahayu and Sudarmin (2015) that ethnoscience-integrated learning can increase students' interest, enthusiasm, and motivation. E-modules loaded with CPS for ethnoscience integrated thermochemistry topicss are good for use in learning because they are equipped with pictures and videos that support the material.

E-modules loaded with CPS thermochemistry integrated ethnoscience materials are easy to use because they make various learning resources into one e-module. The e-module containing the CPS thermochemistry integrated ethnoscience material helps to understand the material because it is equipped with steps to solve problems and train critical thinking. These results are in line with research by Rahayu and Sudarmin (2015) which states that ethnoscience-based science modules are effectively used in science learning and increase student interest in learning. Wahyuni et al (2020) also stated that e-modules that are integrated with the context of ethnoscience and phenomena that occur in life have a great opportunity to improve students' critical thinking skills. The e-module ethnoscience integrated thermochemistry topics CPS loaded is easy to study independently.

CONCLUSION

Based on the research that has been done, it can be concluded that the e-module containing CPS integrated thermochemistry topics ethnoscience of smoking fish is feasible and practical to use in learning. In addition, students can learn easily using e-modules loaded with CPS thermochemistry integrated ethnoscience material because it has characteristics that can provide students to think critically and solve problem.

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