Development of sets-based science e-module to improve critical thinking skills of grade viii students on additive and addictive substances material

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Research Article

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Development of sets-based science e-module to improve critical thinking skills of grade viii students on additive and addictive substances material

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Article Information	ABSTRACT
	The critical thinking skills of junior high school students in Jember are still low, the existing learning is still teacher-centered, and the students lack initiative in asking questions. Based on the results of the national examination of additives and addictive substances, in the last five years, it is relatively low. Through these data, it is known that there are problems related to critical thinking, namely additives and addictive substances. The research aims to develop a SETS-based (Science, Environmental, Technology, and Society) science e-module on additive and addictive substances material to improve students' critical thinking skills. This type of research is Research and Development (R&D) uses a 4D development model. The SETS-based science e-module on additive and addictive substances material developed was tested on research subjects, namely 23 students of class VIII-I, SMP Negeri 1 Jember. The research instruments include validation sheets, learning implementation sheets, pre-test and post-test questions, and response questionnaires. The validation result of the development of SETS-based science e-module on additive and addictive substances material was stated as valid, with a score of 79%. The practicality learning was stated with a score of 3.64%, with a very practical category. The N-gain test score of 0.81 with a high category, so that the SETS-based science e-module on additive and addictive substances material can improve students critical thinking skills. The results of the student's response questionnaires obtained a score of 89% in the very good category. Based on these data, the development of SETS-based science e-module on additive and addictive substances improves students' critical thinking skills. **Keywords:** Critical thinking skills; e-module; SETS
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INTRODUCTION

Additive and addictive substances both are the learning materials taught at the junior high school grade VIII. Additives are food additives that are intentionally added to food during the process of food production, processing, packaging, transportation, or storage (FDA, 2021). The aim of using additives in food is to improve product quality and shelf life (Martins et al., 2017). Flavor enhancers are food additives added to foods, including monosodium glutamate and salt. Other additives include nutritional (sugar) and non-nutritive (saccharin and aspartame) sweeteners, coloring agents, and preservatives. Other food additives are enzymes into synthetic compounds or natural proteins that help break down molecules into smaller ones, such as yeast for alcoholic fermentation (FAO-WHO, 2019). The basic function of food additives is to make food taste better, be more visually appealing, food safer from bacterial contamination, and prevent chemical changes such as oxidation (Saltmarsh & Insall, 2013).

Addictive substances are causing dependence and addiction characterized by behavioral changes. Drugs are addictive substances (Nurlila & Fua, 2017). Drugs can be broadly classified into depressants, narcotics, stimulants, and hallucinogens. Depressants known as sedatives are substances that can slow down brain activity, an example of a depressant is alcohol to induce drowsiness and reduce anxiety. Narcotics or Opioids are drugs that are used medically to relieve pain but have strong addictive potential because they can cause intense feelings of pleasure, and reduce the awareness of someone with a problem so that it becomes something interesting for those who are looking to relieve stress. Stimulants act on the central nervous system to increase energy and alertness while suppressing appetite and fatigue, examples of stimulants are cocaine, amphetamines, and methamphetamine. Hallucinogens provide relaxing and euphoric effects for those who consume them (Singh & Gupta, 2017). Consuming addictive substances for a long time will cause a person to feel addicted, lose the pain, and when consuming will feel happy (Doweiko, 2019).

Additive and addictive substances are learning materials that require divergent thinking. A divergent mindset is thinking that produces various possible ideas or answers to solving a problem, thereby fostering critical thinking skills (Sa'diyyah et al., 2016). The definition of critical thinking skills according to Nuryanti et al., (2018) is a person's ability that needs to be developed, so that a person can face all problems in their social or personal life. Critical thinking is more than just thinking clearly or rationally, but thinking independently. Thinking critically about something means formulating opinions and drawing conclusions by looking at the relationship between ideas, opinions, and points of view (Crockette, 2018). Low critical thinking is a lack of ability to analyze or review an idea due to a lack of understanding ability. The fact on the field is that students' critical thinking skills are still low, according to research that has been done by Handayanti et al., (2018) getting the results that student's ability to think critically in Junior High Schools in Jember is low, and the existing learning is still teacher-centered, and the lack of student initiative in asking questions.

Based on research conducted by Kartina et al., (2019), the results of the national exam on additive and addictive substances material are low in the last five years. In 2015, the results of the national exam of students who answered correctly were 31,47%, in contrast to the results of the 2017 national exam, the percentage of getting the correct answer was 73,02%. Based on these data, it is known that there are problems related to critical thinking, namely additive and addictive materials. Critical thinking is an important skill for all levels of education (Hudha & Batlolona, 2017). Improving critical thinking skills is done by improving interest in learning and reading because when reading, students are required to synthesize, evaluate, interpret, and selectively use information in reading, so

that critical thinking skills can be honed (Al-Shaye, 2021). Another thing that affects students' critical abilities is learning materials that do not involve students in participating in learning so it does not improve students' critical thinking skills. The development of learning materials that are in accordance with student learning needs is the best effort to improve students' critical thinking skills in the current digital era (Siahaan et al., 2021).

The use of textbooks by teachers in the learning process is still less effective to improve critical thinking skills. This refers to the ability to conceptual understanding and problem-solving because textbooks are not communicative and do not ask for feedback (Nasution, 2016). Students rarely read textbooks in printed form because they look unattractive, and the material for additives and addictive substances has not been fully conveyed so students miss lessons and lack insight (Afliansyah, 2022). Research on the development of teaching materials for additives and addictive substances has been carried out by Siswanti et al. (2021) in the form of a problem-based learning textbook. It's time for the development of digital technology, so books are rarely used. Therefore, researchers developed a SETS-based e-module on additives and addictive substances to improve students' critical thinking skills that can be used flexibly because they are packaged in electronic form.

Module development is considered more targeted, especially in the current pandemic era if it is developed in the form of an electronic module (e-module), in line with Sufiyah & Sumarsono (2015), who stated that to support the learning process in a technology-based era, it is necessary to develop an electronic module to replace the print module, thus saving time and training students to study independently. One of the efforts to overcome these problems is to develop a SETS-based e-module. Learning materials based on the SETS approach (Science, Environmental, Technology, and Society) can connect the existing environment with student learning, especially in the aspects of science, technology, environment, and society (Winarti et al., 2015). Through the SETS approach, students are guided to have the ability to think critically about real environmental problems, and technological developments, and be active in solving problems (Akcay & Akcay, 2015). The SETS approach to science and technology literacy learning is integrated with community values and ethics as a solution to environmental problems and is feasible to be applied to learning materials (Chowdhury, 2016).

Electronic module or e-module are learning material that is arranged in detail, measurable, and equipped with using instructions, easy to use for students to understand the material being taught anywhere and anytime because of their flexible feature, and can be carried anywhere via a smartphone, or other gadgets (Setiawan et al., 2021). The electronic module is intended so that students can study the material independently according to their respective abilities (Munadi, 2013). The electronic module has the advantage of saving existing stationery such as paper so it indirectly helps in overcoming the problem of paper waste (Artiniasih et al., 2019). Based on the description that has been presented, the research aims to develop a SETS-based (Science, Environmental, Technology, and Society) science e-module on additive and addictive substances material to improve students' critical thinking skills.

RESEARCH METHODS

This type of research is Research and Development (R&D). This research includes research and development because developed an e-module. This research uses the 4D development method by Thiagarajan et al. (1974), which divides into 4 steps such as define, design, develop, and disseminate. The stages of the 4D development model: (1) the define stage, conduct interviews with science teachers at SMP Negeri 1 Jember before the observation research, front-end analysis, student

characteristics analysis, task and concept analysis, objective analysis, and identification of teaching materials; (2) the design stage, conducted constructing criterion-referenced, media selection is in the form of SETS-based science e-module on additive and addictive substances material, format selection, initial design, and instruments preparation; (3) the development stage, the sample used by the researcher was 23 students of class VIII-I, validation that carried out by 3 science teachers at SMP Negeri 1 Jember, and the test was limited to small groups; and (4) the dissemination stage, conducting test by expert validation, a test of the effectiveness of teaching materials in large classes. However, this research is limited to the development stage only, because reaching the dissemination stage, still requires many stages and an overview of the results of the activities

This research was conducted at SMP Negeri 1 Jember for the odd semester of the 2021/2022 academic year. The participants in this research are class VIII-1 students at SMP Negeri 1 Jember. The total population of class VIII at SMP Negeri 1 Jember is 312 students. The sampling technique chosen by the researcher is purposive sampling. The sample used by the researcher was 23 students of class VIII-I SMP Negeri 1 Jember. The data collection technique in this research uses a validation sheet filled out by 3 science teachers at SMP Negeri 1 Jember, a learning implementation sheet of SETS-based science e-module on additive and addictive substances material filled out by the observer, pre-test, and post-test questions, and response questionnaire filled out by 23 students of class VIII-I of SMP Negeri 1 Jember. The data analysis technique for the validity of the SETS-based science e-module on additive and addictive substances material based on the final score of the validator will determine the results through the following validity formula:

$$P = (\textstyle\sum x) / (\textstyle\sum xi) \times 100\%$$

Description:

P = Percentage of validation score

$\sum x$ = Total of validation assessment score

$\sum xi$ = Total of expected score

100% = Constant

(Akbar, 2013)

The basis for decision-making to determine the validity of the e-module through the following assessment criteria can be seen in Table 1.

Table 1. Validity Level Criteria

Validity Criteria	Percentage
Valid	76-100
Enough	56-75
Less	40-55
Invalid	0-39

(Arikunto, 2006)

The data analysis technique for practicality of SETS-based science e-module on additive and addictive substances material uses the implementation formula according to Arikunto (2006), as follows:

$$\text{Average} = (\text{Number of scores obtained}) / (\text{Number of scoring criteria})$$

The data analysis technique on the effectiveness of SETS-based science e-module on additive and addictive substances material uses questions that have been filled in by students, namely pre-test and post-test questions, by calculating N-gain score according to Hake (1998), with the following formula in below. The category of the N-gain score can be seen in Table 2.

$$(g)= (S\_post - S\_pre) / (S\ ideal - S\_pre)$$

Description:
g = Average of Normalized gain/ N-gain
S_pre = Average of pre-test score
S_post = Average of the post-test score
(Hake, 1998)

Table 2. Category of N-Gain Score

Category	N-gain score
High-g	$(g) \geq 0.7$
Medium-g	$0.7 > (g) \geq 0.3$
Low-g	$(g) < 0.3$

(Hake, 1998)

The response questionnaire analysis technique from the results of the response questionnaires that had been filled out by students after using SETS-based science e-module on additive and addictive substances material in the learning. The percentage of student responses is calculated by the following formula:

$$(P)= A/(B) \times 100\%$$

Description:
P = Percentage of student's response (%)
A = Number of scores obtained
B = Number of maximum scores
(Arikunto, 2006)

FINDING AND DISCUSSION

Development of SETS-based science e-module on additive and addictive substances material uses 4D (define), (design) (develop), (disseminate) development model by Thiagarajan et al. (1974). However, this research is limited to the development stage only.

Define Stage, the results of the application of 4D development model in define stage include interviewing science teachers at SMP Negeri 1 Jember for the preliminary and final analysis. The results of the interviews showed that the school had never received learning materials in the form of a science e-module. Analyzing grade VIII material, namely additive and addictive substances with the approach used, that is SETS. Analyzing the learning objectives to improve students' critical thinking skills. Several problems were found in learning at the define stage. The results of the preliminary and final analysis based on interviews that have been conducted show that SMP Negeri 1 Jember has never used learning materials in the form of an SETS-based e-module. The step of concept analysis is to study the material of additive and addictive substances that are taught according to the existing CC (Core

Competencies) and BC (Basic Competencies). CC and BC used in the development can be seen in Table 3.

Table 3. CC (Core Competencies) and BC (Basic Competencies)

KI	KD
CC 3: Understand and apply factual, conceptual, procedural, and metacognitive knowledge to simple technical and specific levels based on his curiosity about science, technology, art, and culture with human, national, and state perspectives related to phenomena and events look in the eyes	BC 3.6: Explain the various additives in food and drink, addictive substances, and their impact on health
CC 4: Demonstrate the skills of reasoning, processing, and presenting creatively, productively, critically, independently, collaborative, and communicative, in the concrete and abstract realms according to what is learned in school and other similar sources from a theoretical point of view.	BC 4.6: Writing about the impact abuse of additives and addictive substances on health

(Zubaidah, 2017)

The analysis of the define, stage shows that the result of the science teacher interview states there are no teaching materials used to improve students' critical thinking skills in SMP Negeri 1 Jember. It is concluded that the purpose of learning using the SETS-based science e-module on additive and addictive substances material is to improve students' critical thinking skills.

Design Stage, the design stage consists of 5 steps, namely: 1) constructing criterion-referenced; 2) media selection in the form of SETS-based science e-module on additive and addictive substances material; 3) format selection; 4) initial design; 5) and instrument preparation. Designing the e-module framework is creating the opening section, consisting of an e-module cover, introduction, CC, BC, indicator, and learning objectives. The content section contains additive and addictive substances material, and the closing section contains a bibliography and the back cover of the e-module. Designing of systematic and material which the material in the e-module has been designed according to indicators, guided by CC and BC in accordance with the existing syllabus. Additive and addictive substances are materials that accordance with the books owned by students. The learning guide that will be designed is the SETS-based science e-module on additive and addictive substances because the material uses an approach that connects 4 aspects of life, consist of science, environment, technology, and society. Designing of the instrument, that is response questionnaire. The components in the response questionnaire are in the form of an answer category that is valid, enough, less, and invalid.

The e-module's display format uses A4 size paper, Times New Roman font, and 12pt. The selection of media in the e-module is adjusted based on the existing material, namely additive and additive substances, the components in the e-module are adjusted to graphics, images, and explanations, so that the format that will be used in the e-module is obtained, namely using Microsoft Word 2019, then it is converted into PDF format after that entered on Flip Html to get a barcode that will be distributed to students. The following display of e-module's front page and example of the contents can be seen in Figure 1.

Figure 1. (a) Front cover of e-module and (b) material content of e-module

Development Stage, including expert validation test, revision, and N-gain analysis. The result of validity of SETS-based science e-module on additive and addictive substances material were obtained through a validation sheet that had been filled out by 3 science teacher validators at SMP Negeri 1 Jember. The results of validity analysis of the e-module can be seen in Table 4.

Table 4. The Result of Validity Analysis

No	Aspect of Assesament	Percentage Score of Validator (%)			Percentage (%)	Category
		1	2	3		
I	Aspect of Content and Material	92	76	72	80	Valid
II	Aspect of Presentation	100	83	86	90	Valid
III	Aspect of Language	80	73	50	68	Enough
	Average of score	91	77	69	79	Valid

Based on the results of validity analysis of 3 validators, the average score of 79% with valid category. There are several suggestions from the three validators that can be used to improve SETS-based science e-module on additive and addictive substances material, so that it can be applied to the learning process and become more perfect products. The suggestions given by the validator can be seen in Table 5.

Table 5. The Result of Validation Revision

No	Revised Components	Suggestions and Comments	Before Revision	After Revision
1	Contents and Materials	Instructions are not clear, and table entries are not available.	There are no instructions for answering the questions	There are instructions for answering the questions

No	Revised Components	Suggestions and Comments	Before Revision	After Revision
		For evaluation question no. 2, it is necessary to revise the contents of the questions and multiple choices from the answers that only reach option C even though the other questions are in accordance with the standard, namely up to option D.	There are no 4 answer choices in multiple choice question number 2	There are 4 answer choices in multiple choice question number 2
2	Presentation	It is necessary to display pictures of the types of natural dyes because junior high school students still cannot differentiate in detail.	The image shown is less in detail	The image shown is detailed
3.	Language	There is a waste of sentences in some explanations	The sentences used are less effective	The sentences used are effective

The criteria for evaluating the implementation observation sheet consist of 4 criteria, namely introduction, core activity, closing, and class situation. Introduction, main activity, and closing activities are implemented and categorized. However, there were several aspects that were not carried out properly, namely in the introduction activities caused by the researcher not delivering the previous material, and the lack of student response in the core activities because the class situation in the classroom was not conducive. The solution for that case is to improve the LIP (Learning Implementation Plan) for the next meeting so that the class situation is better and more conducive. LIP that is arranged systematically, professionally, and efficiently enables teachers to observe, view, analyze, and predict learning programs as a planned and logistical framework, in line with the statement of Zendrato (2016), that the practicality of the learning process will be better, well-directed through the lesson plans that have been made because the lesson plans are a guide that helps educators in controlling the implementation of learning.

The meaning of valid on a product is the relationship between the product that has been produced and the criteria for making an e-module that are true, correct, and can be tested. In line with the statement Arimadona (2016), namely that a product can be said to be valid or not, it can be determined from the needs of several aspects of the assessment criteria for a product. In SETS-based science e-module additive and addictive substances material, there are three required criteria, namely aspects of content and material, presentation, and language. One type of validity that aims to determine a product made at the development stage is content validity (Vakili & Jahangiri, 2018). Referring to the suggestions given by the validator, namely providing clear instructions, table of contents, and revision of questions and answer keys. Validity ensures that the number of representative components has been taken into account in constructing the concept, and function that indicates how well the elements and dimensions of a concept are explained. The validator's suggestion to validate the presence of the e-module is the addition of clear images and types of natural dyes so that they can be reached by students. Based on research that has been done by Ridho et al., (2020), states that the language aspect is the most important aspect in the validity of a product, because language is a bridge between writers and readers in understanding the content of learning material. Suggestions from the validator related to language aspects include the wastage of words and sentences, and the use of sentences that are less effective, so the researchers revised some sentences to make them more effective. The result of practicality of SETS-based science e-module on additive and addictive substances material was obtained from an implementation observation sheet that had been filled out by the three observers,

namely students of the Science Education Study Program, FKIP, University of Jember who were in accordance with the LIP (Learning Implementation Plan), which consisted of 2 meetings. The following result of practical analysis can be seen in Table 6.

Table 6. The Result of Implementation Observation Sheet

No	Assessment of Activities	Meeting Implementation 1	2	Percentage (%)	Category
I	Introduction	3,75	3,58	3,66	Implemented
	Core Activity				
	a. Dissemination of e-module				
II	b. Application of e-module	3,55	3,55		Implemented
	c. Creation of e-module			3,55	
	d. Practicality of e-module				
III	Closing	3,92	3,75	3,84	Implemented
IV	Class Situation	3,46	3,53	3,49	Implemented
	Score Average	3,67	3,60	3,64	Implemented

Based on the results of the practicality analysis from the implementation observation sheet, it showed score average of 3,64%, with the category being implemented in 2 meetings filled by the 3 observers. However, there were several obstacles, and suggestions were given by the 3 observers for the next meeting. The obstacles and solutions according to the suggestions given by the 3 observers can be seen in Table 7.

Table 7. Obstacles and Solutions

No	Obstacles	Solutions
1	Many students have difficulty scanning the barcode of the e-module.	Visiting one by one of students whom have difficulty scanning the e-module barcode, so that students can access the e-module.
2	Students focuses too much on e-module and pay less attention to the teacher when learning process.	Attract student's attention loudly and firmly, and bring types of natural dyes materials around students, so that student's attention is more focused on learning process.

The result of the effectiveness analysis SETS-based science e-module on additive and addictive substances material based on a test consisting of 6 questions with each indicator of critical thinking. Pre-test and post-test were given to 23 students of class VIII-I of SMP Negeri 1 Jember, a pre-test was given before using the product, and the post-test was given after using the product to determine the improvement of students' critical thinking skills. The average pre-test and post-test scores of these students can be seen in Figure 2.

Based on these data, it can be seen that the average of pre-test and post-test score of students increased. The score of the effectiveness is then calculated by the N-gain formula with the result can be seen in Table 8.

The results of N-gain analysis in the pre-test and post-test are 0,81, with a high category, meaning that after using the product that had been developed, namely SETS-based science e-module on additive and addictive substances material, there was an increase in critical thinking skills. The indicators of critical thinking skills are: 1) interpretation, is the skill of students to interpret a data, experience, or event; 2) analysis, namely the skill of students to investigate the causal relationship of an event or statement; 3) inference, is the skill of students to make conclusions based on events and data that are relevant to evidence; 4) evaluation, is the skill of students to assess the truth of data or information obtained using deductive and inductive reasoning; 5) explanation, is the skill of students to

explain a phenomenon or event based on strong methods, concepts, and considerations in a coherent and detailed manner; and 6) self-regulation, is the skill of students to ensure that they have understood a phenomenon or event (Facione, 2015). Research conducted Putri & Syafriani (2022), shows that the development of sets-based e-module can improve students' critical thinking skills.
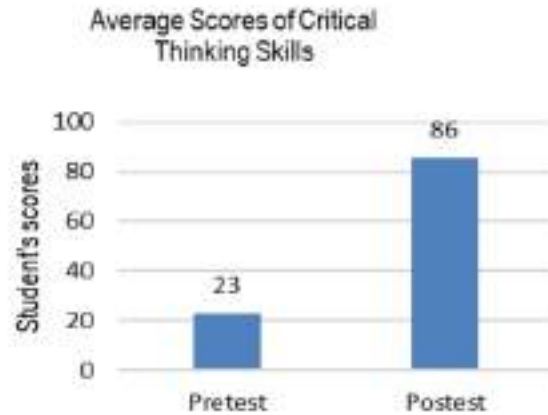
Average Scores of Critical Thinking Skills

Figure 2. Average Score of Critical Thinking Skills

Table 8. The result of N-gain analysis

Component	Class VIII-I	
	Pre-test	Post-test
Amount of student	23	23
Lowest score	12	65
Highest score	41	100
Score average	23	86
N-gain	0.81	
Category	High	

The learning process using the SETS approach provides more opportunities for students to see knowledge from several meaningful contexts and can improve students' critical thinking skills (Umami & Jatmiko, 2013). In line with the research that has been done by Octavia et al., (2015), states the interpretation indicator will increase because students are continuously trained in the learning process to explain the meaning of a problem that has occurred. This is in accordance to Saeed & Rousta (2013), who states that students are able to build high and deep cognitive thinking skills during the learning process, so that it helps them to observe and evaluate various information by involving higher-order thinking skills, resulting in the best answers and decisions which can be obtained. Improving critical thinking skills in students can make them achieves the standard competencies that have been set in the curriculum or to be achieved in the learning process, form of independence, and can solve a problem wisely (Adi & Junining, 2013). Based on the N-gain analysis of 23 students of class VIII-I, score 0,81 was obtained with high category, so that the improve of critical thinking skills reaches the expected category. The results of the analysis using a student response questionnaire sheet with motivation indicators through 6 questions, and response questionnaire through 3 statements can be seen in Table 9.

Table 9. The Results of The Student Response Questionnaire Analysis

No.	Indicator Assessment	Percentage (%)	Category
I	Interest	85	Very good
II	Motivation	89	Very good
III	Response	94	Very good
Score Average		89	Very good

The response questionnaire obtained from 23 students showed the percentage of score average 89% with very good criteria. This shows that the response of students to the use of SETS-based science e-module on additive and addictive substances material in the learning process gave positive results. Supported by the results of the effectiveness of using SETS-based science e-module on additive and addictive substances material, the N-gain score shows 0,81, indicating that the critical thinking ability of students reaches the expected category, which is high. Students' critical thinking ability is a process in which all knowledge and skills are carried out together to solve a problem, make decisions, analyze all assumptions and conduct investigations, or research based on data and information that has been obtained to produce scientific information or conclusio. Therefore, the use of SETS-based science e-module on additive and addictive substances material can improve students' critical thinking skills, and at the same time become an alternative learning media during the COVID-19 pandemic that can be used independently by students.

CONCLUSION

Based on the results of the research, it can be concluded that the use of learning material developed, namely SETS-based science e-module on additive and addictive substances material in learning process can improve students critical thinking skills that indicated by the N-gain score of 0,81 with high category. The results of the validity analysis of SETS-based science e-module on additive and addictive substances material in the aspect of content and material, presentation, and language is 79%, which means it is valid. The result of practicality obtained a score of 3,64% with a very practical category. The result of the student's response questionnaires obtained a score of 89% with a very good category. Therefore suggestions that can be given for further research are: 1) the development of SETS-based science e-module can be applied to other learning materials; 2) addition of interactive features such as videos and games in SETS-based science e-module; and 3) SETS-based science e-module on additive and addictive substances material can be developed through other development methods.

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