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Substance Pressure Material Module-el Discovery Learning to Improve the Critical Thinking Ability of Middle School Students

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Abstract. The low critical thinking ability of Indonesian students is known based on the acquisition of PISA and TIMMS assessments with positions in the lower middle rankings. The lack of teaching materials that facilitate the improvement of critical thinking skills is one of the contributing factors. The purpose of this research and development is to produce a substance stress module to improve the critical thinking skills of junior high school students using model discovery learning. The development model used is 4-D, with stages including define (definition), design (planning), develop (development), and disseminate (spread). Data collection was carried out through a literature review, validation assessment, and e-module practicality response questionnaires. Data collection was carried out through instruments in the form of validation assessment sheets by practitioners and student practicality response questionnaire sheets. Practitioners assess the validity of teaching materials, while their practicality is assessed by students. The results of the material validation were 89.2% (very valid), the media validation was 90% (very valid), the student practicality questionnaire was 76.2% (practical), and the N-gain score was 0.46. These results indicate that the science modules developed are valid and practical for use in science learning.
Keywords: e-module, critical thinking, discovery learning, substance pressure.

Introduction

Natural science (NOS) or natural science is a science that links nature and its contents with the scientific method. NOS refers to the epistemology of scientific activities carried out (Lederman et al., 2013). Science is a scientific product in the form of knowledge, a series of scientific processes (investigations), and a scientific attitude (Tursinawati & Widodo, 2019).

Science learning exposes students to real-life situations around them. In its implementation, science learning focuses on material learned with experience gained from the natural environment (Dewi et al., 2019). Students are directed to connect scientific concepts with problems found in order to construct their conceptual knowledge

and scientific abilities (Bunt & Gouws, 2020). Critical thinking is one of the important thinking skills in improving the quality of student learning (Alsaleh, 2020).

It is important for students to have an understanding of concepts in learning science, including the subject matter of substance stress. But in fact, the material pressure of the substance is still difficult for students to understand. The results of the daily review of material in class VIII in 2019 show that out of 160 students, only 32 have completed above standard of minimum completeness (KKM) 75, while other students are still not finished (Amaliyah et al., 2021). Sapitri et al (2022) added that as a result of observing daily test scores in VIII G, 6 out of 32 students achieved KKM, while in VIII F, 5 out of 33 students reached KKM. This low understanding is caused by abstract material and a lack of visualization, making it difficult to understand (Rahmawati, et al., 2016; Susman & Pavlin, 2008).

Learning is still teacher-centered and dominated by clever students (Sapitri et al., 2022), and the low level of student learning independence is still low because the learning carried out has not led to student learning independence (Lestari et al., 2022)It is important for students to have 21st-century skills to support understanding in learning. These skills are known as "high-order thinking skills (HOTS). The ability to think critically, creatively, reflectively, and metacognitively belongs to the HOTs (Dela et al., 2020; Genuba & Abellanosa, 2018). Critical thinking is an ability that supports learning through student understanding. Ennis (2011) suggests that critical thinking is thinking that focuses on making decisions related to what is done and what is believed. Students will be able to communicate, analyze their ideas for solution by critical thinking (Sutama et al., 2022). Reflective abilities accompanied by reasons that support making a decision (Nuryanti et al., 2021). Critical thinking means knowing and concluding the information obtained to solve a problem and using relevant sources of information (Fauziah & Kuntoro, 2022). Students are prepared to be able to face everyday problems armed with critical thinking (Chusni et al., 2020). Individuals' ability to understand the world and situations around them can be improved by critical thinking (Sutama et al., 2022).

The problem of the low ability of students to think critically in Indonesia still exists today. Learning in schools still does not form active students who discover and build their own knowledge based on the results of the TIMMS and PISA tests. Indonesia ranks 72nd out of 78 countries (Rini et al., 2020). 75.63% of students' critical thinking skills are still low (Prihatingsih et al., 2016). he low ability of students to think critically is reinforced by the results of research conducted Nuryanti et al (2021) which show that the ability to think critically is still low, with the results of students answering correctly at 40.46%, with learning that is still one-way and not yet focused on students (teaching-centered). The low critical thinking of students can be influenced by several factors, one of which is the existence of student learning resources (Kurnia et al., 2014).

The formation of ways of learning and thinking can be formed by critical thinking (Alwehaibi et al., 2012). Critical thinking an be improved through the implementation of learning models that facilitate students discovery of their own knowledge through scientific activities. Discovery learning is an alternative learning model that can be implemented. Learning model discovery focuses on the active activities of students (Yusuf, 2018). Students will be directed to discoveries and investigations carried out to find out scientific concepts to gain knowledge and skills (Susanti & Jamhari, 2016). Discovery learning will make students think critically about problems and efforts to solve them (Setiadi & Elmawati, 2019), and be active in discovering knowledge independently through practicum activities (Rahmawati, et al., 2021).

He type of teaching material that can facilitate students' developing independence in discovering their knowledge is the module. E-Module is a module that is packaged in

electronic form and is equipped with text, video graphics, and images to support learning (Sadikin & Hardianti, 2021; Pane, 2021). Modules are arranged systematically for ease in understanding language and ease in facilitating student independence (Dewi et al., 2019). Based on the explanation that has been disclosed, it is necessary to develop teaching materials in the form of electronic modules to improve students' critical thinking in the matter of substance stress by using models of discovery learning. The aim of this research is to develop a model-based discovery learning module on substance pressure material to improve the critical thinking of junior high school students that is feasible to use.

Methods

The research was conducted using research methodsresearch and development (R&D), which aim to produce products. The research uses a 4D development model with 4 stages covering definition, design, development, and dissemination (Thiagarajan, 1974). The research subjects were students in Class VIII of SMPN 1 Plemahan. The resulting product is in the form of a discovery learning odel of e-modules to measure the use of e-modules on the ability to think critically in the substance stress material. The 4D model research stages define, design, develop, and disseminate the following details the stages of the research and the results obtained.

Table 1. Table of Research Stages.

Stages	Results
Define	The results of the initial analysis are in the form of guidelines for making e-modules.
Design	Preliminary product designs, critical thinking ability instruments, materials and media validation assessment instruments by practitioners, and students' practicality test instruments.
Develop	Substance pressure modules, validation assessment results by practitioners, practicality test questionnaire results, and revision results.
Disseminate	Article product published.

Level definition begins with analyzing the problems found, the characteristics of students, and the learning resources used through literature studies. In addition, at this stage, product guidelines were made, namely for substance pressure modules. In stage design there is initial product creation as well as instruments for assessment. The instruments for assessment consisted of practitioner in the form of validation sheets for media and materials as well as practicality in the form of practicality test questionnaires for students.

At the level of development, this was carried out by making the final product, validating practitioners consisting of 3 Master of Science Education students at UNY and 1 science teacher at SMPN 1 Plemahan, and conducting practicality testing through giving practicality test questionnaires to class VIII students at SMPN 1 Plemahan. The data obtained consisted of quantitative and qualitative data on practitioners' validation scores and practicality questionnaires. Qualitative data obtained from comments and suggestions from practitioners. At this stage, an analysis of the results of the validation and practicality tests is carried out, as is making product improvements based on the input that has been given. Staged dissemination is done by making research articles and publishing them in Sinta 2 accredited journals.

Giving scores on material and media validation using 4 levels on the Likert scale, namely very very agree/always, agree/good, disagree/less, and disagree/disagree (Likert, 1932; Sugiyono, 2015). The Likert scale levels are in Table 2. Product practicality uses a 2-level Guttman scale, namely a score of 1 means "yes" and a score of 0 means "no" (Sugiyono, 2015). The Gutmann scale was chosen because it can provide firm answers to the statements given (Gumanti & Teza, 2021). Module validity analysis was obtained from the validation sheet, which calculated the average score obtained from the practitioner's assessment. Furthermore, the average score obtained was categorized based on the validation category table, which can be seen in Table 3 (Riduwan, 2012).

Table 2. Shoe Scale Linked.

No	(%)	Criteria
1.	4	Totally agree/always
2.	3	Agree/good
3.	2	Disagree or less
4.	1	Don't agree/don't

Table 3. Validation criteria table for validation assessment.

No	Average Score (%)	Category
1.	85-100	Very Valid
2.	70-84.9	Valid
3.	55-69.9	Valid Enough
4.	40-54.9	Invalid
5.	25-39.9	Invalid

(Source: Riduwan, 2012)

Next, a practicality response questionnaire was calculated from the students' responses by calculating the percentage of the average score obtained. An analysis was carried out based on the average percentage score obtained by categorizing it in the practicality criteria table as in Table 4 (Riduwan, 2012). After analysis of critical thinking obtained from the assessment through pre- and post-tests, the N-gain score is calculated. The N-gain value can be classified based on Table 5 (Hake, 1999), with the formula for N-gain as follows:

$$<g> = \frac{Spost - Spre}{Smaks - Spre} \times 100$$

Keterangan:
<g> : N-gain score.
Spost : posttest acquisition.
Spre : pretest acquisition.
Smaks : maximum score.

Table 4. Table of practicality criteria for practicality assessment.

No	Average score (%)	Category
1.	85-100	Very Practical
2.	70-84.9	Practical
3.	55-69.9	Pretty Practical
4.	40-54.9	Less Practical
5.	25-39.9	Impractical

(Source: Riduwan, 2012)

Table 5. N-gain value classification table for module effectiveness.

Mark	Category
g≥0,7	Height
0,3≤g≤0,7	Currently
g>0,3	Low

(Source: Hake, 1999)

Results and Discussion

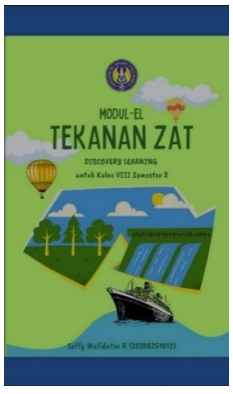
Development of e-modules on material pressure materials with models Discovery learning is carried out through four stages according to the 4D development model (Thiagarajan, 1974). This model is consist of four stages. 4D development model starts with define, design, develop, and disseminate.

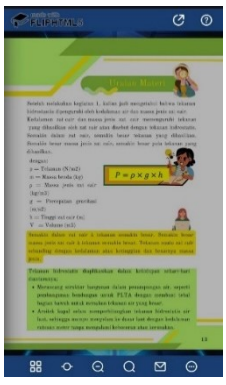
Level definition begins with analyzing the problems found in science learning and the characteristics of students using the literature study method. The results of the literature study showed that the students' ability to think critically on substance pressure was known based on the results of the tests carried out; students still got results below the KKM, learning did not focus on students, and there was a lack of visualization of learning material (Amaliyah et al., 2021; Sapitri et al., 2022). nterviews conducted with science teachers showed that the critical thinking of students were still low; this was known from students' responses to teacher questions, their low willingness to do

assignments, and scores that were still not optimal. Next, an analysis of important concepts is carried out in the substance pressure material. Material pressure will be divided into 4 topics with important and essential concepts, including the principles of solid pressure, liquid pressure, gas pressure, and the application of pressure in everyday life. Based on the results of this analysis, product development is carried out that can facilitate the improvement of critical thinking in substance abuse and provide visualization of learning material in the form of electronic modules. The e-module was developed based on the guidelines for essential concepts in the substance pressure material. So, the learning objectives can be formulated, namely, being able to analyze the concept of substance pressure and its application in life.

Level design (design): the initial product is made, which is developed in the form of an electronic module (e-module) which includes covers, a table of contents, core competencies, basic competencies, indicators of achievement of basic competencies in learning, objectives and learning activities, material breakdown, practice questions (evaluation), key questions, a bibliography, and a glossary. The e-module was developed on material pressure material with student learning activities following the learning model of syntax-discovery learning as follows: 1) providing stimuli; 2) identifying problems; 3) collecting data; 4) processing the data obtained; 5) proving answers; and 6) drawing conclusions. It corresponds to the stages of discovery learning according to the Ministry of Education and Culture (2013), namely stimulation, problem statement, data collection, verification, and generalization (Kharismawati et al., 2020). E-module is packaged in a formflipbook (FlipHTML5), which is used via internet data via a laptop or smartphone. Flipbook has several advantages, including book pages that can be turned over, being easy to use, being able to display videos and images in books, and being able to be accessed online via HTML5 (Asmi et al., 2018). In addition, it can help students achieve goals in 21st-century learning. At this stage, critical thinking instruments are made, which consist of pre-test and post-test questions that will be tested on students. Making validation and practicality instruments for practitioners and students.

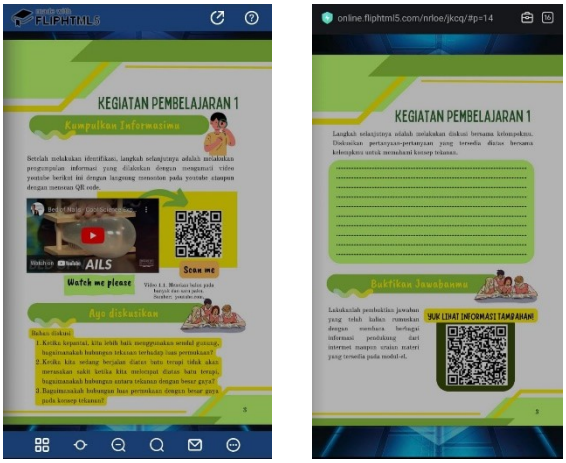
At the level of development, the development of the e-module is based on the design of the content components that have been compiled, which can be seen in figure 1. The e-module is equipped with learning video images and QR codes that contain additional information and learning videos obtained through youtube as shown in Figure 2. Videos, pictures, and QR codes in the e-module will provide visualization of abstract pressure material, making it easier for students to understand it. The use of videos on youtube can increase students' understanding of certain materials (Jannah & Atmojo, 2022), and student learning outcomes can increase (Kuncoro & Hidayati, 2021). Modules have a systematic and specific structure for learning certain themes (Puti & Jumadi, 2015).





(a) (b)

Figure 1. a) Display of the cover page; b) Description of the material in the e-module.



(a) (b)

Figure 2. a) Adding videos and QR codes to visualize material, and b) QR codes to access additional materials to prove answers.

After being developed, the el-module is tested for validity, which consists of assessing material validation and media validation by practitioners. The assessment was carried out by three UNY science education master's students and one science teacher. The results of the e-module expert validation test are shown in Table 6. The results of the e-module validation test by media experts are shown in Table 7.

Table 6. Table of material expert validation results.

Indicator	V1	V2	V3	V4	Average	Criteria
Compatibility with discovery learning	86	94	87.5	94	90.4	Very valid
Adaptability enhances critical thinking	87.5	87.5	87.5	87.5	87.5	Very valid
Content eligibility						
Presentation eligibility	92	92	92	92	92	Very valid
Average	83	91	91	83	87	Very valid
					89.2	Very valid

Table 7. Media expert validation results table.

Indicator	V1	V2	V3	V4	Average	Criteria
Graphics	91	91	91	91	91	Very valid

Language	87.5	8.5	91	91	89	Very valid
Average					90	Very valid

The validation assessment related to the material obtained an average result of 89.2% with a very valid categorization. Furthermore, the validation results in the media obtained an average percentage of validation of 90% with a very valid categorization. Based on the results of the material and media validation test, it can be said that the material pressure modules with the model discovery learning are valid and can be tested on students at school. The percentage on conformity indicators with discovery learning obtained an average of 90.4%, the appropriateness of increasing critical thinking obtained an average of 87.5%, content feasibility was 92%, and presentation feasibility was 87%.

Based on the results of the material validation, it is known that the e-modules developed are in accordance with the syntax discovery learning process, which consists of stimulation, problem statement, data collection, verification, and generalization (Kharismawati et al., 2020). According to menurut Nitko & Brookhart (2011) the main indicators of critical thinking are basic classification, assessing basic support, concluding, follow-up classification, and strategies and tactics. This is contained in the matter of evaluating critical thinking in the e-module and learning activities in the e-module Cristina & Rusilowati (2015) tated that the reading presented to students must be easy to understand and adapted to the age and level of understanding of the students. Interesting teaching materials have colorful pictures, interesting content, and easy-to-understand language (Nugraha & Syafi'ah, 2020). Rofiah et al. (2018) found that children aged 13–16 years can use their thinking, or logical thinking, in carrying out activities that are oriented towards higher-order thinking skills. Mashinta et al. (2016) found that the teaching materials contain letters that are not too small in size, are equipped with pictures to clarify the information presented, and contain resources with proportional image sizes. Qualitative data obtained based on the validator's comments, namely completing the identity on the cover, to complete the identity of the cover Improvements to the module identity on the cover are shown in Figure 3.

Figure 3. The result of repairing the completeness of the e-module identity on the front cover.

The measurement of critical thinking is done through tests before and after learning. The values obtained will then be carried out by the N-Gain test to find out whether there are differences in test scores before and after going through the pretest and posttest. Based on the N-Gain test, the difference in values between the pretest and posttest is a number of 0.46. Test result N-Gain is found in Table 8.

Table 8. Tabel uji N-Gain.

Test	Average	*N-gain*	Criteria
Pretest Posttest	51.00 73.50	0.46	Currently

Average value The pretest and posttest show an increase from 52.00 to 73.50. The increase in the average indicates an increase in the ability of students to think critically when they have not used the e-module and after learning. This is reinforced by the acquisition of scores N-gain a number of 0.46 in the moderate category. The use of material pressure material modules with model-discovery learning can experience an increase. These results are in line with Sakti et al (2020) finding that using module discovery learning based on ethnoscience is able to increase the ability to think critically, with differences in increasing the ability to think critically from cycle I (58.69) to cycle 2 (63.45). Use discovery learning in learning can improve student learning outcomes through the discovery of concepts through independent activities that students do (Mu'affifah & Prasetyo, 2018).

The developed e-module is tested for practicality through a practicality questionnaire for students. The results of the e-module practicality questionnaire are in Table 9.

Table 9. Table of student practicality questionnaire results.

Indicator	Average Score (%)	Criteria
Evaluation of the use of e-modules	73	Practical
Language	79.75	Practical
Interest	76.4	Practical
Ability to work on critical thinking questions	75.7	Practical
Average	76.2	Practical

Based on a practicality questionnaire conducted on students with evaluation indicators of the use of e-modules, language, interest, and the ability to work on critical

thinking questions, an average of 76.2% was obtained in the practical category. The practicality of the e-module is obtained from aspects of its usability, language, interest, and ability to work on critical thinking questions. The percentage of e-module usage indicators is 73%. The language indicator gets a percentage of 79.75%. The language used in developing the module must be adapted to the users of the module, namely teachers and students, so that it is easily understood and used by users (Permatasari et al., 2019). The interest indicator obtained a percentage of 75.7%. In developing teaching materials, they must have clear and attractive illustrations or pictures to increase students' understanding and interest when using them (Rangsing, et al., 2015). The indicator of the ability to work on critical thinking questions is 76.2%.

Conclusion

The product developed is in the form of a substance stress module to improve students' ability to think critically in junior high school students using models of discovery learning, and the results of material validation were 89.2% (very valid), media validation was 90% (very valid), and students' practicality questionnaire was 76.2% (practical). The difference in results between the pretest and posttest before and after using module-el is shown by the score N-gain of 0.46 with moderate categorization. The developed IPA modules can be declared valid by practitioners and practical by users. It can be concluded that the development carried out can produce products in the form of science modules that are suitable for use in science learning. In further development, science modules can be developed to improve the critical thinking of SMP-based students. Discovery learning on other material can carry out development in the form of learning media with pressure material by utilizing various learning media to get better material visualization. Can develop e-modules equipped with AR or VR.

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