

The Validity of Teaching Materials using POE Model to Increase the Student's Critical Thinking Skills in Junior High School on the Pressure Topic

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Abstract:- This research aims to produce the valid teaching materials. The teaching materials are developed using POE model to increase students' critical thinking skills in junior high school on pressure topic. The teaching materials developed consist of the lesson plan, student worksheet, student book, the critical thinking skills test, and concept mastery test. The five indicators of critical thinking skills measured in this study are providing simple explanations, the ability to give reasons, make conclusions, make and determine the results of considerations based on the application of facts, and choose alternative solutions. Model of teaching materials development used this research is 4D model. Validity data were obtained from the validation by experts using the validity instrument. The data obtained were analyzed descriptively quantitatively based on the validity criteria of teaching materials. Based on the assessment of three validators, the developed teaching materials had very valid category.

Keywords:- Validity, teaching materials, POE, pressure topic, critical thinking skills, concept mastery.

I. INTRODUCTION

The education system in Indonesia currently refers to the 2013 curriculum. Teachers have an important role in achieving the 2013 curriculum objectives. The 2013 curriculum teachers are required to have competence and always be creative in the implementation of learning including in the science learning process [1]. Measurement of learning outcomes is not only important to master the extent of students' understanding of science knowledge, but also understanding of various aspects of the scientific process, as well as the ability to apply the scientific process in real situations. This is in accordance with the nature of science education, namely increasing the competencies needed by students to be able to fulfill their lives [2]

Science concepts are very close to the daily life of students, so knowledge cannot be transformed from teacher to student [3]. The teacher encourages students to have experience and conduct experiments that allow them to find their own concepts through sharing activities during learning. Thus students will be more active to solve a

problem and involve a reasoning that can practice critical thinking skills, which in turn can also improve students' understanding of concepts. The students must be able to analyze and evaluate the amount of information available [4].

Development of the potential of students as intended can be implemented with good learning [5]. One of the learning model that is suitable for overcoming the above problems is the POE (Predict-Observe-Explain) learning model. POE is a model of learning by using experiments started with the presentation of a problem where students are encouraged to estimate the chances of that happening (predict) followed by observation of direct observation on this issue (observe your) and then proved by experiment to be able to find the truth of the initial allegations in the form of explanation or explain [6].

The POE (Predict-Observe-Explain) learning model is one of the learning models developed to find students' abilities in predicting natural phenomena and their reasons for making these predictions [7]. POE learning model is done through a series of stages that are organized such that students can master the competencies [8]. Optimal development of critical thinking skills are closely related to how to teach [6]. Based on these statements, the POE learning model is expected to be able to improve the students' critical thinking skills.

Based on the phase of the POE learning model, at the predict phase student activities that meet critical thinking indicators according to Ennis namely determine an action. Then in the observe phase, there are indicators of critical thinking carried out by students, namely considering whether the source can be trusted or not, defining terms, and concluding [9]. In the explain phase, student activities that meet the indicators of critical thinking are providing simple explanations. From the description above, each phase of the POE learning model can affect critical thinking skills.

The rapid changing of technology in life and work force has led students to require themselves with a range of skills and capabilities, including critical thinking [10]. Critical thinking are more required in workplace at this time than in the past [11]. Critical thinking also becomes most important skills in industrial revolution 4.0 eras [12]. Therefore, teaching critical thinking is demanded in today's

global society together with communication, collaboration, and creativity [13, 14].

Critical thinking is the ability of the brain to explore in depth the issues, ideas, findings, and the fact before accepting or continuing an opinion or conclusion[15]. The statement affirmed that the application of the POE model can improve students' critical thinking skills. That is because the stages of POE learning require students to find and explore the findings in the observation activities (Observe) and also the initial knowledge that students already have (based on prediction results) into a new knowledge. In addition Petchone et al stating that critical thinking consists of two components, namely the ability to estimate a reason well and the willingness, desire, and tendency to do an action or experiment and trust the reason also supports that the application of the POE learning model can improve students' critical thinking skills [16].

One of the topic in science teaching in Junior High Schools that is suitable to be taught using the POE model is pressure topic. In learning the pressure topic required activity or a practicum, but teachers in some schools are still not optimal to guide students during the practicum. The competence in that topic requires critical thinking skills such as analyzing the results of experiments related to the influence of the liquid lifting force, linking concepts with daily life that can later be applied in their lives [17]. Therefore, efforts are needed to practice thinking skills to support the learning process and hone one component of 21st century skills that students must possess. Based on the background description above, this research will develop a teaching materials using the POE model to improve students 'critical thinking skills and students' understanding of concepts in the material pressure of the eighth grade junior high school.

II. METHODS

This research is a type of development research due to developing teaching material consisting of lesson plan, Student Worksheets, Student Textbooks, critical thinking tests, and concept mastery tests. The learning device development model in this study uses the 4D model from Thiagarajan, et al. [5]. The 4D development model consists of 4 stages, namely (1) define, (2) design, (3) develop, and (4) disseminate [18]. In this study only limited to the stage of development and trial only, the the fourth stage is disseminate not done.

At the define stage, the thing that is done is to define and define the learning conditions that include curriculum analysis used, then to analyze the students, analyze the concept of the material, analyze the assignments and continue the formulation of learning objectives. In the design stage, the thing that is done is the initial design of the teaching material that will be developed, namely the preparation of questions or critical thinking tests, and concept mastery tests, the

selection of media in the learning process, then the selection of learning device formats developed which consist of lesson plan, student books, student worksheets and assessment instruments which includes critical thinking skills tests and concept mastery tests. The result of selecting the teaching materials format at the initial stage called draft I. Furthermore this draft I will be reviewed by the supervisor to be given advice and improvement.

In the develop phase, the teaching material developed will experience a revision process into draft II. This Draft II will be validated by the science lecturers and teachers of science. The purpose of validation is to generate valid teaching materials that has been validated and revised based on the input of experts so worthy a limited trial and tested extensively. Data from the teaching materials validation results are analyzed quantitatively. Based on the results of the average value of the validator is used to determine the quality of the teaching materials. The results of the validity data were analyzed using quantitative descriptive analysis by calculating the average value given by the validator. This score is then described qualitatively by being interpreted according to the criteria in Table 1.

Score Interval	Category	Description
$3.60 \leq V \leq 4.0$	Very valid	Can be used without revision
$2.60 \leq V \leq 3.59$	Valid	Can be used with a minor revision
$1.60 \leq V \leq 2.59$	Less valid	Can be used with major revisions
$1.00 \leq V \leq 1.59$	Invalid	Not yet in use and requires consultation

Table 1:- Validation score criteria of Teaching Materials

Table 1 above is adapted from Ratumanan & Laurens [19]. The valuation agreement is calculated based on the similarity of values given by three validators with the formula:

$$\text{Percentage of Agreement} = \left(1 - \frac{A-B}{A+B}\right) \times 100\%$$

Notes:

A = Highest score given by the validator

B = Lowest score given by the validator

Based on Table 1 it can be seen that a teaching materials is said to be valid if it gets a score at an interval $2.60 \leq V \leq 3.59$ and is said to be very valid if it gets a score at intervals $3.60 \leq V \leq 4.0$. Then an instrument is said to get an agreement if the percentage of agreement obtained is $\geq 75\%$. Based on the criteria in Table 1, the teaching material developed in this study are said to be valid to be used in the learning process if they get a score of ≥ 2.6 which meets the minimum valid criteria [19]. Furthermore, if a teaching materials that is developed gets a category of less valid or invalid,

then the revision is done, then the validation process is carried out again.

Calculation of reliability necessary to calculate the percent similarity values provided by three validator, with the formulation:

$$\text{Percentage of agreement} = 100\% \times \left(\frac{A}{A+D} \right)$$

Notes:

A = Frequency of matches between validator

D = The frequency of mismatches between validator

An instrument is said to be good if the reliability obtained ≥ 0.75 or 75% [20].

III. RESULT AND DISCUSSION

A. Results

Validation of learning devices developed includes validation of lesson plan, validation of Student worksheets, validation of Student Textbooks, validation of critical thinking skills test, and validation validation of concept mastery tests. The teaching material developed in this study are said to be valid for use in the learning process when obtaining a minimum score of ≥ 2.66 [19].

➤ Analysis of lesson plan validation results. The lesson plan consists of three meetings that were based on the POE learning model. The provision of writing basic competencies (KD) refers to Permendikbud 24 of 2016. Components in lesson plan included school identity, subject, class/semester, subject matter, time allocation, KI (core competencies), KD, indicator of competency achievement, purpose lessons learned, material summary points, learning method, media and materials, learning resources, learning steps, assessment and appraisal appendices [21]. The validation results of the three validators can be seen in the following table.

Aspect	Average score	Category	Reliability (%)
Lesson plan format	3.7	Very valid	83.8
Learning activities	3.7	Very valid	83.4
Supporting learning activities	3.7	Very valid	100
Language	3.7	Very valid	88.9

Table 2:- Validation Results of Lesson plan

Based on Table 2, the results of the validation of the lesson plan from the three validators obtained an average score of 3.7. This means that the lesson plan prepared by the researcher belongs to the category of very valid and can be used in the learning process. This is in accordance with the minimum validity criteria with a minimum score ≥ 2.6 [19]. Thus it can be said that

the developed lesson plans can be used as a study guide in the classroom with little revision. The results of the calculation of the reliability of more than 75% so that the instruments developed can be said to be good. [20]. The reliability scores of the three validators for RPP validation averaged 89%. So that all components of the validated aspects can be said to be reliable and can be continued for data collection in the field.

➤ Analysis of the results of the validation of student worksheets. The student worksheets developed were POE-based student worksheets that were used in three meetings. The first meeting discusses the pressure of solids, the second meeting discusses the pressure of liquids, and the third meeting discusses the pressure of gases. Each student worksheet contains components such as a title, KD, destination activities, measures of activities tailored to the learning model POE syntax, and indicators of critical thinking skills, as well as a list of references. Each student worksheet starts with an initial motivation to bring up phenomena related to the material to be studied. Each worksheet is equipped with a grouping of students into study groups, the worksheet guidelines that contain the formulation of the problem, the materials used for the activity, the steps of the activity carried out, observation tables, data analysis, answering questions, and conclusions. In student worksheet there is a conclusion drawing activity students must be able to answer the discussion questions that have been provided so that students truly understand the information or material that has been done based on the results of the experiment. This is consistent with the constructivist view that students are given the opportunity to discover concepts independently, obtain new information, improve rules that no longer apply [22]. The student worksheet is also equipped with a worksheet key that makes it easy for the teacher to manage learning. The results of the validation of the three validators can be presented in Table 3.

Aspect	Average score	Category	Reliability (%)
Student worksheet format	3.6	Very valid	81.5
Content eligibility	3.5	Very valid	80.0
Language	3.6	Very valid	85.2

Table 3:- Validation Results of Student Worksheet

Based on Table 3 the validation results from three validators obtained an average score of 3.6. This means that student worksheets prepared by researchers can be categorized as very valid and can be used as learning materials [19]. So, it can be said that the development of POE-based worksheet can be used to improve critical thinking skills. The results of calculation of reliability of three validators also showed good results that is more than 75% [20]. So the student worksheet can be used for data collection in the field.

➤ Analysis of the results of the validation of student textbooks: Student textbooks prepared by researchers cover the topic of substance pressure. This textbook consists of learning objectives, concept maps, material subject matter pressure, pictures and illustrations related to the material, practice questions, glossary, and bibliography. The average results of student textbook validation are presented in Table 4.

Aspect	Average score	Category	Reliability (%)
Organizing studentbooks	3.7	Very valid	95.5
Explanation of concepts	3.6	Very valid	86.7

Table 4:- Validation Results of Student Books

Based on Table 4 the validation results from three validators obtained an average score of 3.65. This means that student books that are arranged by researchers are categorized into very valid categories and can be used as teaching materials [19]. So, it can be said that student textbooks developed can be used as POE-based learning media to improve critical thinking skills and students' understanding of concepts. The reliability calculation results show good results with a score obtained more than 75% [20].

➤ Analysis of validation of critical thinking skills tests. Critical thinking skills test developed in the form of essay tests with a total of 10 questions. This question was developed referring to five critical thinking indicators, namely providing simple explanations, the ability to give reasons, make conclusions, make and determine the results of considerations based on the application of facts, and choose alternative solutions [9]. Before validation is performed, the critical thinking skills test developed is first reviewed by the supervisor to get suggestions for improvement. Validated aspects of the critical thinking skills test include, content validity, language, and question writing. The results of validation tests on critical thinking skills are presented in Table 5.

Aspect	Average score	Category	Reliability (%)
Validity of contents	4.0	Very valid	80
Language and writing questions	3.9	Very valid	83.4

Table 5:- Validation Results of Criticalthinking skill test

Table 5 describes the results of the validation of the critical thinking skills test. Of the three aspects assessed, the average score obtained was 3.9 with very valid criteria meaning that the critical thinking skills test instrument in the form of 10 essay questions can be used to determine the extent to which students' critical thinking skills (pretest) and also used to assess increased

critical thinking skills after learning to use the device that was developed (posttest) [19]. The reliability obtained exceeds 75% so it can be said that the instrument is well developed [20].

➤ Analysis of the results of the concept mastery test validation. The concept mastery test was developed in the form of multiple choice tests containing 10 questions. Validated aspects include content validity, language, and question writing. The results of the validation of the concept understanding test are presented in Table 6.

Aspect	Average score	Category	Reliability (%)
Validity of contents	4.0	Very valid	76.7
Language and writing questions	3.9	Very valid	76.7

Table 6:- validation Results of Concept Mastery Test

Table 6 describes the results of the validation of the concept mastery test instrument. Of the three aspects assessed, the average score obtained was 3.9 with a very valid criterion meaning, the concept understanding test instrument in the form of 10 multiple choice questions can be used to determine the extent of understanding students' concepts after learning to use the developed device [19]. The reliability calculation results show more than 75% so it can be said to be good [20].

B. Discussion

Validation of POE-based teaching materials to improve students' critical thinking skills has obtained very valid results and limited testing can be done. POE learning model is one model that can help activate students in the learning process because in this model students not only listen but also observe events that occur through experiments [23]. This model provides an opportunity for students to express their initial knowledge related to the material provided, the collaboration between students during the discussion, the exchange of opinions between students with other students, the conceptual changes in the knowledge possessed by students [24].

The POE learning model can train students to organize their understanding and their abilities as evidenced by observation both through experiments and demonstrations so that learning becomes meaningful. In theory, the POE learning model is based on constructivism. Understanding constructivism in learning shows that students build their own knowledge, which is strongly influenced by what they already know [25].Based on some of the opinions above it can be concluded that this POE learning model can help students in being able to explore their own ideas in their way in science in real situations through practicum to investigate the ability to predict, observe, and explain in the learning process and interact with each other with his friend. Before conducting a research trial, only the teaching materials developed need

to be validated beforehand by experts. Validation is done by lecturers and junior high school science teachers, this is done so that the teaching materials developed are suitable for research.

Lesson plan is a plan of learning activities for one or more meetings. The lesson plan is developed from the syllabus and then turns into student learning activities in an effort to achieve basic competencies (KD). The material prepared in the RPP was developed with the POE model on substance pressure material. POE is a learning model using experiments that begin with the presentation of a problem where students are invited to predict the likelihood that occurs (predict) followed by observing by making direct observations of the problem (observe) and then proven by conducting experiments to be able to find the truth from the initial suspicion in the form of explanation (explain). Through these three activities, students are expected to understand and be able to apply their knowledge in real life [25]. Lesson plan validation results obtained are included in the category of very valid, but there are some suggestions for improvement. These suggestions include adjusting basic competencies to learning objectives. The basic competencies taken in this research are explaining the pressure of substances and their application in daily life, including blood pressure, osmosis, and capillarity of transport tissues in plants. The research that will be carried out focuses on the material of physics concerning the pressure of substances, so that the study taking only three meetings related to the pressure of solids, liquids, and gases. There is a suggestion from the validator to add the learning material, because keeping in mind in the subsection the pressure of liquid matter the material to be taught to students is very broad. Based on these suggestions, the researchers added the number of students' face-to-face meetings, which were initially three meetings into four meetings to discuss more broadly related to liquid pressure which includes material hydrostatic pressure and Archimedes law.

One of the most important components in learning is the presence of student books. Student books that have been developed with reference to procedures, phenomena with problems discussed in the topic, foster curiosity, and the level of development of students' thinking. The student book had been validated and declared as a feasible student book that can be used in science teaching materials pressure material. The textbook that was developed discusses the concepts of solid pressure, liquid pressure and gas pressure. There is a suggestion from the validator that the researcher is asked to discuss further about the pressure of the liquid, adjusted for suggestions on the improvement of the lesson plan. Researchers are also asked to add a mini lab that students can do at home. Based on these suggestions the researcher makes a column next to the material summary to provide instructions to students on how to do a mini practicum that can be done at home. This is supported by the opinion that the teacher does not act as the only source of learning in charge of pouring subject

matter to students, but more importantly is how to facilitate student learning [26].

The student worksheet serves as a student guide that can be used to carry out investigative activities or problem investigations, so that it can assist students in developing concepts through discovery activities, so as to train students to find new concepts using scientific methods. Student worksheets can also be used to practice critical thinking skills by referring to scientific activities such as formulating problems, making hypotheses, making research variables, analyzing data from activities or observations, and drawing conclusions. The student worksheet developed in this study refers to the stages of the POE learning model and refers to indicators of critical thinking skills. The student worksheet developed has been validated and the results are very feasible to use so that it can facilitate students in learning science to improve critical thinking skills. The worksheets that have been developed are good, there is a description of the stages of the POE learning model and also a description of the stages of the critical thinking indicators. Suggestions from the validator are only about revamping the data collection results that are good and right with the aim of making it easier for students when filling the table of experimental results. According to information processing theory, where there are three main characteristics of information processing theory namely thought processes, modifying mechanisms and self modification. But sometimes there are students who only come to the characteristics of the changing mechanism, so students only enter information into their memory but do not modify it to adjust the response to new learning situations and the information is not stored in long-term memory [27]. Based on these theories, the teacher must help students to facilitate learning by facilitating students through developed learning materials.

The critical skills test contains 10 essay questions. This test is adjusted to the indicator of critical thinking. The test is equipped with a rubric or grid of answers to facilitate the teacher in the assessment process. Critical thinking skills indicators developed in this study refer to the opinion of Ennis [9]. Critical thinking indicators used in questions consist of five indicators, namely providing simple explanations, the ability to reason, make conclusions, make and determine the results of considerations based on the application of facts, and choose alternative solutions. The results of the validation of critical thinking skills tests categorized as very valid with an average score of 3.9 and can be tested in the learning process in the classroom [19]. In the aspect of the problem of critical thinking skills there are a few inputs from the validator regarding the phenomena used in the problem. The phenomena set forth in the questions must be natural phenomena that are true and can be reasoned by students. Critical thinking is essentially an active process where someone thinks about various things in depth, asking questions for oneself, finding information that is relevant to oneself rather than accepting things from others [28].

The latest development of teaching materials is the concept mastery test. Concept mastery tests were developed to measure students' understanding of material taught by the teacher or that students have learned. A good concept mastery test must be able to measure students' ability to understand the material being taught. The material to be taught by researchers that includes material pressure solids, liquids and gases. In the matter of liquid pressure there are two sections to be discussed namely concerning hydrostatic pressure and the law of Archimedes. The results of the validation of the test understanding of the concept has been expressed very valid with a score of 3.9 and can be tested for a learning process in the classroom [19].

All components of the validity of the learning tools developed in this study were classified as valid learning tools. This model was developed based on the results of previous studies and also meets the demands of time in accordance with the latest Indonesian curriculum which is to make students active in finding valid information [29]. The model also has a novelty that focuses on increasing students' truth-seeking disposition in learning science. The design of the POE learning model is also supported by the state of learning theory. They educate psychology; character building; and learning theory which consists of information processing theory [27], psychology [30], constructivism [31], and motivation theory [5]. All the developed learning tools are also included in the valid category, this means that the learning tools are designed logically and all learning devices are consistently connected to each other [28].

IV. CONCLUSIONS

Based on the results of the validation and discussion, it can be concluded that the teaching materials using the POE model to improve students' critical thinking skills and concept mastery in the pressure topic that includes lesson plan, student worksheets, student books, critical thinking skills tests, and concept mastery tests declared very valid, so that it can be used in the science learning process in Junior High School on pressure topic.

ACKNOWLEDGMENT

We thanks Dr. Titin Sunarti, M.Si. and Drs. Setyo Admoko, M.Pd. from the Department of Physics, Universitas Negeri Surabaya, and Ms. Yuniar Dwi Setyaningrum, S.Pd. a science teacher from SMPN 22 Surabaya for helping in validation of the teaching materials developed.

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