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Development of E-Module Problem Based Learning Models on Temperature and Heat Physics Materials

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ABSTRACT

In the 21st century, a person must have various skills in order to develop and keep up with the times. The important skills that must be possessed are 4c, namely: creative thinking, critical thinking and problem solving, communication and collaboration. problem-solving skills on temperature and heat materials are still low, so a model learning is needed to increase these skills. materials of teaching in consist of modules are needed. With the use of technology, e- modules are made so that students are more interested and enthusiastic. This research purpose to find out how the validity of the product of making e-module. This research is development with the plomp model. Preliminary research, obtained initial data in the form of an analysis of student needs and an analysis of the Basic Competition 3.4 curriculum on temperature and heat material. Expert review, the e-module is validated by five validators. The data collection instrument was a validation questionnaire. The data analysis used the Aiken's V index. The validation data analysis result obtained that the PBL physics e-module model on temperature and heat material was very valid. The validity test consists of three assessment components. Material and language with an average value of 0.88 was very valid. Characteristics of the e-module with an average value of 0.90 was very valid. The PBL model with an average value of 0.86 was valid. The average result of these three components is 0.88 in the very valid category. Based on the results the e-module is valid.

Keywords :E-module, Heat and Temperature, Problem Based Learning.

I. INTRODUCTION

The 21st century is a time of developing technology and science. A person must also be able to keep up with the times by requiring various skills. those skills are commonly known as 4C skills, namely: creative thinking, critical thinking and problem solving, communication and collaboration [1]. In education, with these abilities, students are expected to be able to develop and utilize their knowledge to face the world of work. The 21st century, which is full of technology, has changed learning from teacher-centered to student-centered. Students can get information from a variety of sources that can be accessed from anywhere. The challenges of the 21st century require students to have the ability to think critically and problem solve. To realize these goals, the right learning model is needed. One of the models that fulfill the 4C skills is the Problem Based Learning Model.

Problem Based Learning (PBL) is a learning model in which the delivery process is carried out by explaining a problem, formulating relevant questions, and facilitating investigations. The problems raised are contextual problems that students usually find in their daily lives [2]. PBL is effective in stimulating interest in science, enhancing knowledge construction, and improving problem-solving skills [3].

According to Al-Tabany, the advantages of the PBL model are that students understand the concept because they process it themselves so that they find the concept, students are active in finding solutions to problems, and have high thinking skills, students solve problems related to the life around them so that they can increase self-confidence and motivation. to solve the problem yourself [4]. Florensia also revealed that the PBL model of learning is a realistic model of learning in students' lives, this model stimulates students' ability to discover new knowlage, can help students to practice thinking in dealing with things and help increase student activity, so that learning activities are no longer centered on educators discover [5].

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The PBL model is suitable to be applied to learning of physics. Sawitri et al argue that through the PBL model of learning students can develop knowledge and skills to solve problems and physical phenomena in their environment by using their metacognitive skills. The PBL model of learning is suitable to be applied in high school because the model of learning is complex, demands higher-order thinking skills and good analytical skills [6]. Through the PBL model students are required to be more active in problem solving. Rahmi argues that the PBL model of learning is very influential on learning of physics, based on the level of education it can improve student outcomes of learning [7].

Physics is a subject that discusses the characteristics and natural phenomena that occur in it. One of the physics materials that is closely related to natural phenomena and daily life is temperature and heat material. It discusses the concepts of temperature, expansion, material changes, heat transfer and how heat is applied in daily life. Phenomena such as railroad tracks that bend due to expansion, hot water mixed with cold water so that the temperature becomes moderate, ice cubes in room temperature will melt over time, the occurrence of land winds and sea breezes and many more. However, there are still many students who have difficulty solving more complex problems in temperature and heat material. Azizah in her research revealed that 76% of students had difficulty solving physics problems, 19% of students did not understand problem solving solutions, 5% of students who were able to solve problems [8].

Students often experience difficulties when solving problems on temperature and heat material. Many students have not mastered the concept as the main capital in solving problems and students find it difficult to connect temperature and heat concepts with previous concepts. Siringoringo in his research showed that most students scored 51 to 75. Students who scored less than the average were 42.4%. Students who got this score had difficulty at the problem solving stage [9]. Based on these data, there are still many students whose problem solving skills, especially in physics material, are still low, so the problem-based learning model is suitable for improving students' problem solving skills. In the learning process, supporting teaching materials are also needed that can make students learn independently.

Information and communication technology is an important component in life. The role of information technology is used in various fields, such as health, transportation, research and in the world of education [10]. The development of Information and Communication Technology (ICT) has an impact on the use of computers and *smartphones* as a medium to convey information growing rapidly. This technology is also used by the world of education, especially by teachers to communicate with their students [11]. The rapid advancement of technology and communication can be used to manage and develop learning programs to help students achieve the expected competencies. The development of technology changes the learning orientation from conventional learning to digital learning. One of the uses of advances in communication and information technology is optimizing the contribution of learning media as intermediaries for teachers and students. Current technological developments allow the development of online or digital learning media so that the communication process in learning runs effectively and efficiently [11].

Phenomena and problems in physics, especially in the matter of temperature and heat, sometimes there are phenomena that cannot be observed directly by students, due to limited time, tools and materials. Explanation of material that requires pictures, illustrations or videos can improve student understanding. Therefore, materials of teaching are needed that can overcome these problems. Materials of teaching that can be presented are the electronic modules. The module can make students learn independently and be guided by the elements in the module. This module is used in accordance with the development of the curriculum in Indonesia. With the module, it can focus student activity in the process of learning [11].

The use of e-modules in learning physics can improve skills of critical thinking, skills of science process, and improve student outcomes of learning. To achieve learning objectives, e-modules can be integrated by applying model of learning such as the PBL model [12]. With the electronic module, PBL is good for students to understand learning by thinking about finding and solving problems based on theories and concepts that can be applied in everyday life and educating students to be independent in understanding science [13]. Therefore, learning materials are needed that can overcome these problems.

Materials of teaching that can be applied are e-modules with additional innovations such as images, videos andanimations. The e-module can be created using the *articulate storyline application*. With *articulate storylines* we can create interesting modules because they can contain images, videos, animations and of course interactive. Using this application is easy because it is similar to *power point* but has features such as *adobe flash* or *macromedia flash*. The output of this application is that we can open it on a *cellphone*, web, or on a laptop, both *online* and *offline*. Based on this description, the author wants to make an E-Module with a Problem Based Learning (PBL) Model on the Material of Temperature and Heat in Physics for Class XI Senior High School.

II. METHOD

This type of research is development research, namely *research and development*. Development research is a research method used to produce a product [14]. The model used in this study is the Plomp model. Plomp states that development research is needed to design and develop a product as a solution to complex research problems and advances science [15]. Products that are developed and become solutions to problems can be in the form materials of teaching, modules and so on to optimize the learning quality. The object of this research is the physics e-module of the PBL model on the material of temperature and heat physics in class XI semester 1,

namely Basic Competition 3.4 and Basic Competition 3.5.

The first research phase, namely *Preliminary Research*, conducted an analysis of several journals on student needs regarding the PBL model e-module. Curriculum analysis was carried out to study the scope of learning material, an analysis was carried out on Basic Competition 3.5. The next stage is the *development /prototyping phase*. This research is limited to *expert review*. The research stage is shown by the tessmer diagram as follows:

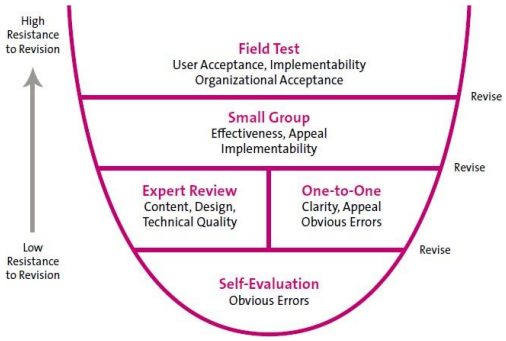

Figure 1. Tessmer chart (Plomp: 2013)

Self-evaluation or self-assessment is carried out by the researchers themselves after finishing designing or e-modules to see errors that appear in the initial product. The first design result from the researcher is called *prototype* I and after being revised by the researcher is called *prototype* II. Then *prototype* II is validated by the validator, the revised e-module from the validator is a valid e-module.

The instrument used was a *self-evaluation* questionnaire and a validation questionnaire. The validation questionnaire contains three assessment points, namely the assessment of material and language aspects, aspects of e-module characteristics and aspects of *problem based learning*. The technique for data analysis used is descriptive quantitative analysis technique. The validation on materials results of teaching depend on the score given by the validator. The validity test assessment questionnaire was obtained from the checklist data on the validity sheet which was compiled using a Likert scale. The data obtained were analyzed using the *Aiken's V index.*

III. RESULTS AND DISCUSSION

A. Research Results *Preliminary* Research Phase

The analysis results from several journals are that a module is needed to contain a variety of images and videos to attract attention, improve understanding, and improve student outcomes of learning [16]. Students need systematic learning resources that can be understood independently. Students need e-modules that contain text, images and learning videos that are different from print modules, so students are required to learn to solve problems using their own way [13].

Teachers need electronic modules that contain video content about physical phenomena, contain pictures, graphics, contain practice questions, short materials, competency tests, learning instructions, and use easy-to-understand language. Based on 21st century skills, students must have skills of critical thinking, so the electronic module learning media must be equipped with questions that can practice skills of critical thinking [17]. In learning physics on the material of temperature and heat students are less interested in solving physics cases that exist in everyday life so that students do not like physics subjects. The learning media needed is a learning video. Because students need learning styles that can increase students' interests and attitudes towards temperature and heat material by seeing, hearing, discovering and doing experiments [18]. The results obtained in the literature study are, (1) the PBL model consists of five stages, Specifically, orienting students to challenges, setting them up for learning, supervising individual and group investigations, creating and presenting work, and assessing the outcomes of the problem solving process. (2) the characteristics of the e-module are *self-instructional*, *self-contained*, *stand-alone*, *adaptive* , and *user friendly* . (3) the e- module component consists of cover, introduction, table of contents, glossary, basic competencies and indicators, learning objectives, module usage instructions, activity sheets, material descriptions, summaries and evaluations.

B. Research Results Development Phase (Develop Protyphing)

Prototype was created based on the guidelines for the preparation of e-modules made by the Directorate General of Primary and Secondary Education of the Ministry of Education and Culture in 2017. *Prototype* I was made by the researcher and carried out a *self-evaluation* or self-assessment, at this stage the researcher saw the completeness of the e-module components and produced *prototype* II. Furthermore, *prototype* II was validated by experts with three assessment components, namely: material and language assessment, e-module characteristics and PBL models.

The first is the assessment of the material and language components which consist of aspects of the feasibility of content and aspects of language. The component of the content feasibility aspect consists of 15 indicators, namely 1) the suitability of Basic Competition with KI in the 2013 curriculum. 2) Conformity of indicators of competency achievement with Basic Competition. 3) Conformity of learning objectives with indicators of competency achievement. 4) The suitability of the material with the learning objectives. 5) Complete temperature and heat material. 6) The questions given relate to the material being studied. 7) The substance of the material in the e- module is in accordance with the concepts in physics. 8) The contents of the e-module can broaden students' knowledge. 9) Experiments related to material temperature and expansion. 10) The experimental steps of temperature and expansion can be understood easily. 11) Concept map according to the material of temperature and heat. 12) Concept maps are easy to understand. 13) The summary contains the entire core of the material.
14) The evaluation questions measure each indicator. 15) The evaluation questions vary. The validation results of the content feasibility aspect are as follows:

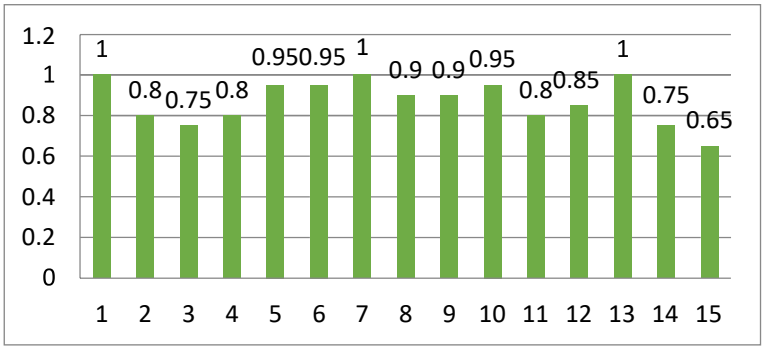

Figure 2. Validation Results of Content Feasibility Aspects

The language aspect component consists of 6 indicators, namely 1) The language used is easy to understand. 2) the language used is in accordance with the rules of Indonesian. 3) The language used is communicative. 4) The physical equations used are clear. 5) Consistent use of letters. The validation results of the language aspects are as follows:

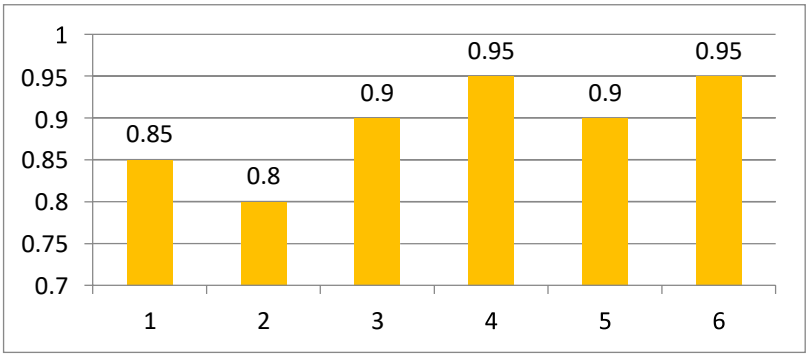

Figure 3. Results of Language Aspect Validation

The second is an e-module assessment questionnaire consisting of general e-module characteristics, application usage and graphics. The components of the characteristics of the e-module consist of 14 indicators which are divided into 5 points, namely *self-instruction* which consists of 4 indicators: 1) The objectives are clearly formulated and can describe Basic Competition. 2) There are learning materials that are packaged in specific activity units so that they are easy to study thoroughly. 3) Contextual. 4) There is feedback. *Self contained* which consists of two indicators: 5) The material is packaged in a complete form 6) The material is separated based on indicators and is accompanied by examples and practice questions. *Stand alone* which consists of four indicators:

7) Used as the main source of learning. 8) Equipped with PBL model steps. 9) Can be used for independent study. 10) The order and arrangement of the material is carried out systematically. *Adaptive* which consists of two indicators: 11) E-Module can adapt to the development of science and technology. 12) Flexible in use. *User friendly* consists of two indicators: 13) The instructions on the e-module are clear and helpful to the user. 14) Display of attractive images and formats. The validation results of the characteristics of the e-module are as follows:

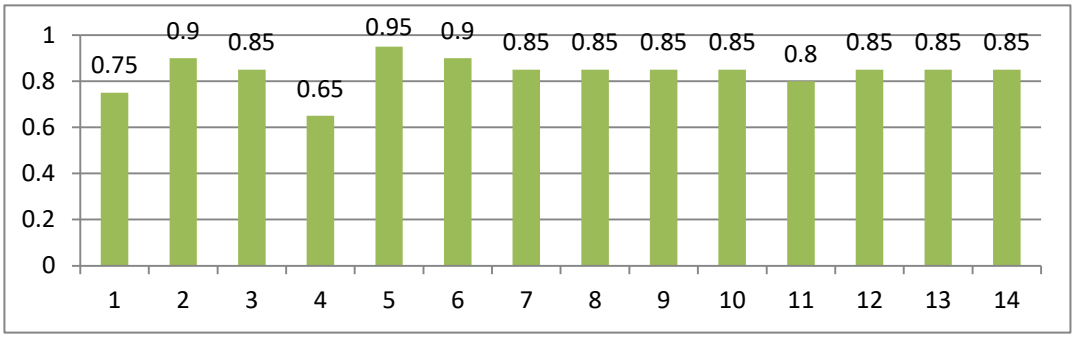

Figure 4. Validation Results of E-Module Characteristic Aspects

The application usage component consists of 3 indicators, namely 1) the clarity of the operating guide. 2) consistency of navigation button layout. 3) ease of use of buttons. The validation results of the application usage aspects are as follows:

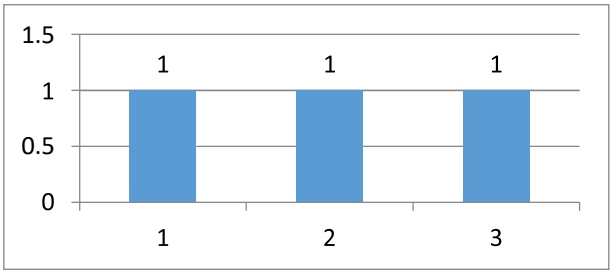

Figure 5. Validation Results Aspects of Application Usage

The graphic component consists of 9 indicators, namely 1) The color and layout of the cover is attractive.
2) Cover illustration according to the material. 3) The typeface used is clear to read. 4) The font size used is clear to read. 5) The placement of elements in the layout of titles, subtitles, and illustrations is consistent according to the pattern. 6) The integration of color, shape and arrangement between components (writing, pictures, graphics, etc.) in contrast, increases interest in the material presented. 7) The video presented can be seen clearly. 8) The illustrations and images presented can be clearly observed. 9) The overall PBL model physics e-module design is attractive. The validation results of the application usage aspects are as follows:

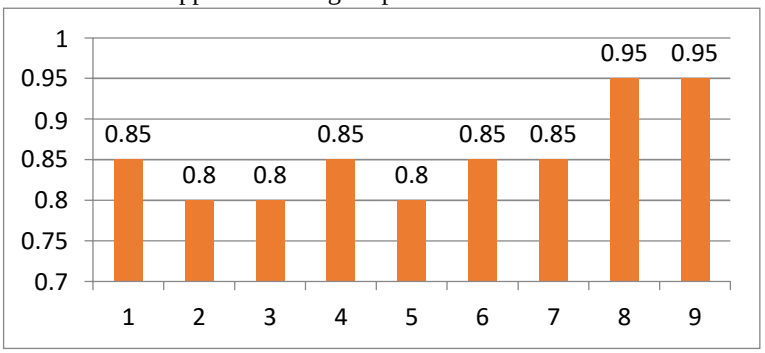

Figure 6. Graphical Aspect Validation Results

The third is a *problem-based learning assessment questionnaire* consisting of 14 indicators which are divided into 5 points of assessment, namely organizing students towards problems consisting of 4 indicators: 1) Problems are presented as the beginning of learning. 2) The problems given are clear and related to the material. 3) The problems given relate to the real world of students. 4) The problems presented can make students motivated to solve them. Organizing students to learn consists of 1 indicator: 5) There are sources of material related to the problem. Assisting individual and group investigations consists of 2 indicators: 6) There is a clear experimental procedure related to the problem. 7) Experimental procedures are arranged in a coherent manner. Developing and presenting the work results consists of 3 indicators. 7) Experimental procedures are arranged in a coherent manner. Developing and presenting the work results consists of 3 indicators: 8)There are

investigations results that are in accordance with the problem. 9) There are conclusions from the the investigation results. 10) Produced answers from solving these problems so that students understand the concepts presented. Analyzing and evaluating the problem solving process consists of 2 indicators: 11) There is a process of reflection on the investigation. 12) There is a solution to the problem solving. The suitability of the PBL stages consists of 3 indicators: 13) The material presented is in accordance with the stages of the PBL model. 14) The ability of e-module content to guide students and find physics concepts independently. 15) E-modules facilitate students to carry out the process of learning by solving problems critically and creatively. validation of PBL aspects as follows:

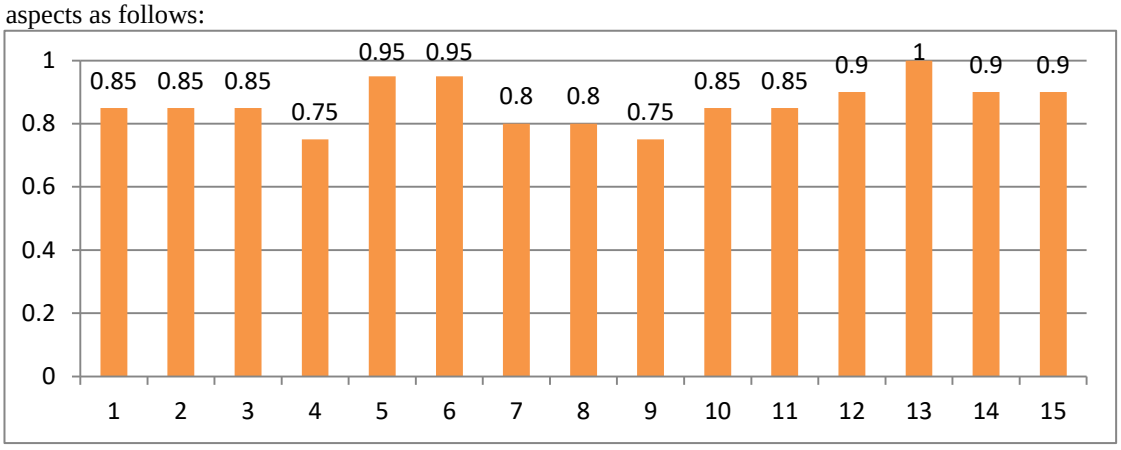

Figure 7. Validation Results of Problem Based Learning Aspects

The average validity of the e-module problem based model of learning on temperature and heat physics material for class XI Senior High School is 0.88 in the valid category. The following is the average data from the validation results:

Table 1. Average Validity Results

No	Rated aspect	Average	Category
1	Content eligibility	0.87	Very valid
2	Language	0.89	Very valid
3	Characteristics of e-module	0.84	Very valid
4	Application usage	1.00	Very valid
5	graphics	0.87	Very valid
6	Problem based learning model	0.86	Very valid
	Average	0.88	Very valid

Based on table 1, the average result of 6 components is 0.88 in the very valid category. The data shows that the problem-based learning e-module model is feasible to use in physics learning, the reasons are:

First, in the component of content and language feasibility aspects, the material presented in the e-module is in accordance with the basic competencies in the 2013 curriculum. Contains material about temperature, thermal characteristics of a material, heat capacity and conductivity, and heat transfer. Second, in the aspect component of e-module characteristics, the making of e-modules has been in accordance with the guidelines for preparing e-modules. The module is equipped with learning instructions so that students can actively learn independently, worksheets used for students to answer the problems presented, and the module contains feedback in the form of worksheet keys so that students can self-assess their ability limits [19].

Third, in the aspect component of application use and. The application used to create e-modules is articulate storyline. This e-module can be used in the form of online or online by accessing it from the internet, equipped with the use of navigation buttons to make it easier for users, attractive graphics equipped with videos and animations so that students are interested and motivated to learn and solve the problems presented [20].

Fourth, in the aspect component of the PBL model. The e-module is in accordance with the learning stages of the problem-based learning model. Learning begins with the presentation of problems then students search and find solutions. To solve the problems presented, students must gather information, carry out experiments, work together in groups, and think about how to solve problems [21]. The problems presented in the e-module improve 4C skills [22]. Critical thinking and problem solving skills: students are required to think about how to solve the problems presented by searching and collecting information, making observations or conducting experiments to get answers to problems. Creativity: students are required to think creatively, be more open-minded in solving problems. Students who have high creativity are able to think and see a problem from different sides or points of view. Collaboration: students form groups and work together to solve problems, so that they can improve their ability to work together. Communication: students in groups present the results of solving the problems they get, thus improving communication skills.

The limitations in this research are time constraints, so this research is limited to the validation stage only. The e-module was also not tested on students so that it could not see the results of the effectiveness of the e-module.

IV. CONCLUSION

Based on the research results and discussions that have been carried out, it can be concluded that the validity of the PBL model e-physics module is in the very valid category. This can be proven based on the data analysis results obtained an average validation result of 0.88. The validation results on the material and language components obtained an average of 0.88 with a very valid category. The validation results on the characteristic components of the e-module obtained an average of 0.90 with a very valid category. The validation results on the *problem based learning model components* obtained an average of 0.86 with a very valid category. Based on these data, the e-module physics problem based learning model on temperature and heat material has met the requirements in terms of validity so that it can be used in schools. E-modules need to be tested on a wider range of students, so that the scope and quality of this product can be fulfilled, because this research only reaches the validity stage, it has not yet reached the stage of practicality and effectiveness.

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