

VALIDITY OF STEM INTEGRATED STATIC FLUID E-MODULE TO IMPROVE STUDENT LEARNING OUTCOMES

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ABSTRACT

The rapid development of technology and information brings many impacts in various fields, especially in the field of education. Student learning activities with digital technology in learning cannot be separated, so students are expected to master technology such as electronic modules. Student learning outcomes seen from the final semester exams for class XI MIPA students are quite adequate with an average score of 5 classes, namely 62, so it is necessary to follow up with the manufacture of STEM integrated static fluid electronic modules to improve student learning outcomes. The purpose of this study was to determine the validity of the STEM integrated module with professional static fluid material flip pdf software. The research method used by Hannafin and Peck's instructional development model is focused on product-oriented learning design. The instrument used in the study was an electronic module validation sheet that involved 5 lecturers as product validators. Data analysis showed that the development of electronic teaching materials scored 85.63 which belonged to the category of good use. Therefore, the design of the STEM-integrated static fluid material electronic module can help online learning activities during the pandemic. Furthermore, this study is suggested to investigate the practicality and effectiveness of electronic modules.

Keywords : E-Module; Static Fluid; STEM



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I. INTRODUCTION

21st-century skills in particular arise because of the reality of global education that has not fully accommodated the educational needs of the technological era. The 21st century is a century where technology and information are available and can be used massively. The 21st century is also referred to as the third-millennium era as a continuation of the era of globalization known as the transformation of industrial society into a knowledge society which is marked by advances in science and technology so that it requires every human being to have the ability to think at a high level [1]. The rapid development of technology and information brings many impacts in various fields, especially in the field of education [2]. The sophistication of communication tools such as the emergence of the Iphone, android can be used in the field of education and assist in the passage of national education.

National education has made curriculum improvements from the KTSP curriculum to the 2013 curriculum. In this curriculum there is a change in the learning pattern from teacher-centered learning to student-centered learning, so students need to explore the material to be studied on their own. In addition, the 2013 curriculum requires students to be able to develop their hard and soft skills. Hard and soft skills can be developed during the learning activities.

Learning activities involve the interaction of teachers and students in the education unit. According to the Ministry of Education and Culture (2018), learning activities require improving learning strategies and techniques to focus on students, utilizing digital technology, using innovative approaches, and all parties understanding technology. Based on this explanation, learning is student-centered. Student activities with digital technology in learning cannot be separated, so students are expected to master technology. One of the uses of digital technology in learning is electronic teaching materials.

Physics learning is the process of obtaining physics according to the nature of physics through the scientific method to achieve optimal learning outcomes. Physics learning aims to equip students with the knowledge,

understanding, and ability to develop science and technology [3]. In learning physics, students can solve problems through the scientific method.

In the physics learning process, teachers are required to be more innovative. This is in accordance with Permendiknas Number 16 of 2007 concerning Standards for Academic Qualifications and Teacher Competencies which states that one of the demands for the pedagogic and professional competence of teachers is to develop learning resources and teaching materials. To assist students in learning physics, especially static fluid material, various interactive learning media are needed, one of which is the e-module. E-module is a module that contains material concepts and discussion of questions summarized in electronic form and can be added with learning videos, animations, and quizzes through Google forums or other learning applications.

The physics learning process was previously carried out in schools with a face-to-face learning process but in 2020 it switched to online learning. This is due to the rapidly increasing spread of the covid-19 virus and has resulted in students learning from home with the help of online classes and media shared online. Online learning during the pandemic affects student learning activities and student learning outcomes. This online learning makes students struggle with numbers in learning physics at home.

The first real condition is the average value of the use of physics teaching materials, which is 50 and is included in the low category. The second real condition seen from the use of the STEM integrated electronic module in class XI IPA at SMA N 1 Pasaman was stated to be non-existent. Based on the real conditions described, it is necessary to develop physics teaching materials such as the development of electronic modules (e-modules). The third real condition is seen from the results of the odd semester final exams for students of class XI MIPA 1 to 5, namely 62.6 are in the sufficient category. And the fourth real condition seen from the UN scores in the last five years on the basic fluid competence was found to be 49.85 in the less category. Thus, it is necessary to develop a STEM-integrated static fluid e-module to improve student learning outcomes for class XI SMA.

Based on the KBBI, the module is a diktat of teaching and learning program activities that can be studied by students with minimal assistance from the supervising teacher, including planning goals, as well as tools to assess, measure the success of students in completing learning. It was also formulated by the Education Development Agency of the Ministry of Education and Culture, that the module is the smallest detailed learning program unit. The module is a teaching material that is systematically arranged in language that is easily understood by students according to their level of knowledge and age so that they can learn on their own with guidance from educators [3]. In the world of teaching, the module is defined as a complete, independent unit, and consists of a series of learning activities in achieving learning objectives [4]. The module is one of the complete learning resources with learning activities arranged systematically by the teacher to achieve learning objectives.

The module that is circulating around us is the print module with several weaknesses. The first weakness is that there are many pages that make the module weight heavy [5]. Second, the presentation is static, cannot be changed [6]. Third, the basic material of paper is very vulnerable, requiring large amounts of paper with high production costs [6,7]. The disadvantages of this print module can be supplemented with an e-module.

E-module is a form of presentation of independent teaching materials that are arranged systematically into the smallest learning units to achieve certain learning objectives [8]. An e-module is an electronic version of a printed module that can be read on a computer and designed with the required software. E-modules have the same advantages as print modules. The advantages of e-modules are that they can present various forms of graphics, animation, audio, and video; involve students interactively so that it is not boring, and students are more active in the learning process; provide additional information easily and completely through internet access to various sources; fast and practical in its use; does not require a large space in using and storing it [9]. With these advantages, it can make it easier for students to use electronic modules in physics learning, given the current conditions.

E-modules are systematically arranged which are displayed in an electronic format. Some of the menus that can be loaded on the e-module include audio, animation, and navigation. The use of electronic modules with laptops and cellphones makes it easier for students to study anywhere, not only at school. Applications that can be used to create e-modules include Exelearning, Kvisoft Flipbook Marker, 3D Page Flip Professional, flip pdf professional. On this occasion, the researcher developed an electronic module using the Professional Flip pdf application.

Previous research that is relevant to this research is a reference for researchers. Relevant research includes research by Ayu, et al [10], Tenti, et al [11], Fahlevi, et al [12]. This research has differences with relevant research. First, the teaching materials made are electronic modules. Second, physics learning materials in

teaching materials include static fluid materials. Third, teaching materials are aimed at improving student learning outcomes.

The physics e-module that will be developed by the researcher in addition to using flip pdf software also pays attention to the contents in it. The physics e-module has integrated content of Science, Technology, Engineering, and Mathematics (STEM) [11]. STEM e-module is learning that integrates science, technology, engineering, and mathematics in the learning process [13]. The linkage of science, technology, engineering, and mathematics adds to the complexity of learning and facilitates student learning in an integrated STEM learning environment [14]. The application of STEM in learning activities consists of 4Cs, namely creativity, critical thinking, collaboration, and communication so that students can find innovative solutions to real problems and can convey them well [13].

The material in the STEM integrated e-module used is static fluid. Static fluid studies fluids that are at rest [15]. The fluid does not flow, for example, liquid in a bucket that does not leak, or gas in a closed container [16]. We often encounter fluid in our daily life, for example when bathing, washing, watering plants, leaking tires, and many other activities involving fluids. Static fluid matter is a science that studies substances flowing in stationary conditions, especially liquids and gases, which is one of the materials in the subject of physics in which each indicator has a relationship in everyday life [17].

Based on the results of the preliminary study and the problems presented, the title of this research is "Validity of Stem-Integrated Static Fluid E-Module to Improve Student Learning Outcomes". The purpose of this study is to determine the validity of the STEM integrated e-module with professional flip pdf software for static fluid material. The instrument used in the study was an e-module validation sheet that involved 5 lecturers as product validators. Validation sheet instruments include material substance, visual communication display, design, software utilization, and STEM.

II. METHOD

Based on the background of the problem, this research uses a type of product-oriented development research. This type of development research refers to the development model of Hannafin and Peck. Hannafin & Peck's development model is one of the learning design models to produce products. The purpose of research on the development of the Hannafin and Peck model is to produce a product that can assist in solving a problem. This study develops an integrated STEM electronic module on Static Fluids to improve student learning outcomes for class XI science.

The Hannafin and Peck development model consist of 3 stages, namely: (a) Needs assessment; (b) Design (Design); and (c) Development and implementation [18,19]. The first stage is a needs analysis (Needs assessment). This needs analysis stage refers to 1) analysis of learning problems; 2) analysis of the characteristics of students; 3) analysis of learning objectives; 4) analysis of learning settings. The second stage is the product design stage (Design). The design stage is carried out by collecting all sources related to the product. The results at the design stage are in the form of storyboards or static fluid e-module designs. The third stage is development and implementation (Development and Implementation). The learning product in the form of a static fluid e-module that has been developed is then validated so that a device is obtained that suits the needs and can be implemented in real learning. The third stage aims to determine the effectiveness of using the STEM-integrated static fluid e-module.

Scientific research data were obtained using data collection instruments. The data collection instrument for needs analysis was in the form of an observation sheet on learning implementation problems, a student characteristic questionnaire sheet, an observation sheet for learning objectives, and learning settings for the lesson plan implementation. At the e-module development stage, an instrument in the form of a validation sheet is used which involves experts. Validation sheet instruments include material substance, visual communication display, design, software utilization, and STEM.

The data analysis technique used in this research is descriptive statistical analysis, normality test, homogeneity test, t-test for 2 unrelated samples. Descriptive statistical analysis is statistics used to analyze data by describing or describing the data that has been collected as is without making conclusions that apply to the public [20]. The normality test aims to see whether the sample comes from a normally distributed population or not. Normality test used Lilliefors test. The homogeneity test aims to see whether the two sample data have a homogeneous variance or not. For the homogeneity test, the F test was carried out. After obtaining the data that was normally distributed and homogeneous, a t-test was performed for the two unrelated samples. The use of the

T-test is carried out by comparing or testing the average difference between the experimental class and the control class [21].

III. RESULTS AND DISCUSSION

Based on the Hannafin and Peck development model, it is necessary to carry out a needs analysis as an early stage in the research. The first needs analysis is the analysis of learning problems at SMA N 1 Pasaman. The observation instrument used is guided by the 2016 Minister of Education and Culture Regulation Number 22 regarding the implementation of learning. The implementation of learning is the implementation of the lesson plan, including preliminary, core and closing activities. Analysis of learning problems can be seen as Table 1.

Table 1. Analysis of Implementation Problems

Learning Implementation Components	Component Value
Introduction to learning	70
Learning core activities	70
Closing part of the lesson	69

Based on the results of observations in table 1 of the analysis of learning problems, 70% of opening learning activities were carried out, 70.45% of core learning activities were carried out and 68.75% of closing activities were carried out in the Minister of Education and Culture. Overall, 69.73% of learning activities in SMA N 1 Pasaman are in accordance with the implementation of ideal learning. The implementation of learning has not used the STEM approach in learning.

The second needs analysis is the analysis of the characteristics of students at SMA N 1 Pasaman. The instrument used is a questionnaire on student characteristics with 4 components, namely: interest in learning, learning motivation, learning attitudes, and student learning styles. Analysis of student characteristics can be seen as shown in Figure 1.

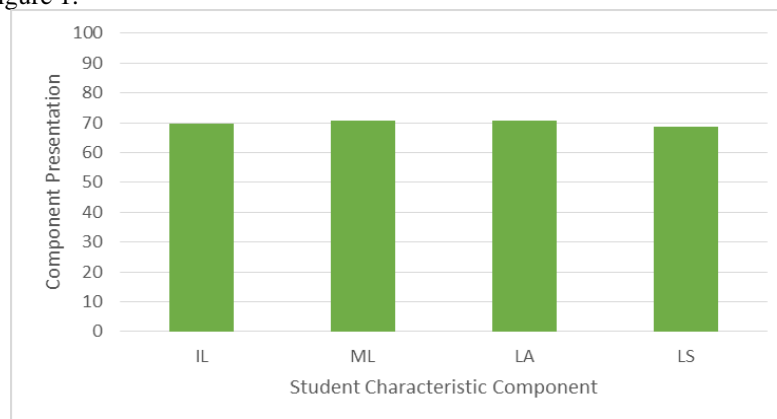


Fig. 1 Analysis of the characteristics of student

Based on Figure 1, the questionnaire that has been distributed to 30 students shows that students' interest in learning is 69.55%; student learning motivation 70.73%; student learning attitude 70.58% and student learning style 68.52%. Overall, 69.84% student characteristics fall into the good category, student characteristics affect student learning outcomes. Student learning outcomes for the 2020 odd semester final exams from 5 classes obtained an average score of 62, the value of these learning outcomes is included in the sufficient category, and not in line with expectations. The STEM-integrated static fluid e-module contains media images, videos and learning links aimed at increasing student interest, motivation, and learning attitudes according to their learning style.

The third needs analysis is the analysis of the learning objectives of the 3 physics materials through the design of the physics teacher learning implementation. The observation instrument used is guided by the completeness of the ABCD structure on learning objectives and learning competencies. The analysis of the completeness of the learning objectives in the learning implementation plan can be seen as table 2.

Table 2. Analysis of Learning Objectives

RPP	Learning objectives
RPP KD 3.1	90
RPP KD 3.2	60
RPP KD 3.3	70

Based on table 2, the observation sheets on the learning implementation plan for the three basic competencies, namely the equilibrium of rigid bodies, elasticity, and static fluids are obtained, the values are 90%, 60% and 70%. The average value of the completeness of learning objectives for the three basic competencies obtained is 73% in the good category.

The fourth needs analysis is the analysis of learning settings on 3 physics materials through the implementation of physics teacher learning plans. The observation instrument used is guided by the 2016 Minister of Education and Culture Regulation Number 22 regarding the implementation of learning. The analysis of learning settings for the three basic competencies can be seen in table 3.

Table 3. Analysis of Learning Settings

RPP	Learning settings
RPP KD 3.1	71
RPP KD 3.2	68
RPP KD 3.3	61

Based on table 3, it is found that the analysis of learning settings for three basic competencies, namely rigid body equilibrium, elasticity, and static fluid, is 71%, 68%, and 61%. The average value of the suitability of learning settings with Permendikbud Year 2016 Number 22 regarding Learning Implementation obtained 66.67% is in the good category. The learning setting analyzes the suitability of the opening part of learning, core activities, and closing in the teacher's RPP with the 2016 Minister of Education and Culture Regulation Number 22 concerning the Implementation of Learning.

Based on the main purpose of the study, the results of the validation of the STEM integrated static fluid e-module were obtained from the assessment of 5 validators, the value of this product validation was obtained after conducting a needs analysis and product design. The first is a preliminary analysis, the second is the product design in the form of an integrated STEM static fluid e-module and the third is the development and implementation of the validation results of the e-module product.

The STEM-integrated static fluid e-module was validated by UNP physics lecturers. The results of the validation of the static fluid e-module are obtained from the validator's assessment of the product through the validation sheet instrument. The product validation sheet instrument contains 5 components, namely material substance, visual communication display, learning design, software utilization and STEM assessment [22]. The assessment on the validation sheet starts from a value of 1 to 4 for each indicator. The value of a component is obtained from the average validator's assessment for each indicator in the component.

The first component of the validation assessment instrument is the material substance component. The material substance component consists of four indicators, namely 1) truth (KB), 2) material coverage (CM), 3) contemporary (KK), 4) legibility (KT). The results of the assessment of each assessment item are converted into scores. Validation values are placed on the x-axis and for each indicator of the assessment items are placed on the y-axis. The results of the analysis of the substance of the e-module material are shown in Figure 2.

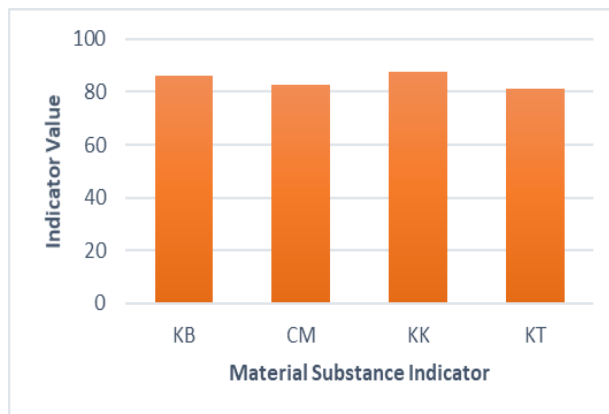


Fig. 2. Material substance

Based on Figure 2, the static fluid e-module obtained material substance values varying from 81 to 88. The values given by the validator for each material substance component can be categorized as very good. The indicator of the truth of the material is rated at 86.25 stating that the material described in the module is proven to be true and does not deviate from the actual science. The material coverage indicator is rated at 82.50 stating that the material coverage is in accordance with the depth of the static fluid material it should be. The current indicator is rated at 87.50 stating that the material in the static fluid module connects the material with contemporary things that are easy for students to understand. The readability indicator is rated at 81.25, stating that the writing on the e-module can be read well in the use of the static fluid e-module. The average value of the material substance indicator, which is 84.37, can be categorized as good material substance used.

The second component is the visual communication display. The visual communication display component consists of 6 indicators, namely: 1) navigation (N), 2) letter (H), 3) media (M), 4) color (W), 5) visual (V), 6) layout (L). Validation values are placed on the x-axis and for each indicator of the assessment items are placed on the y-axis. The results of the analysis of the e-module visual communication display are shown in Figure 3.

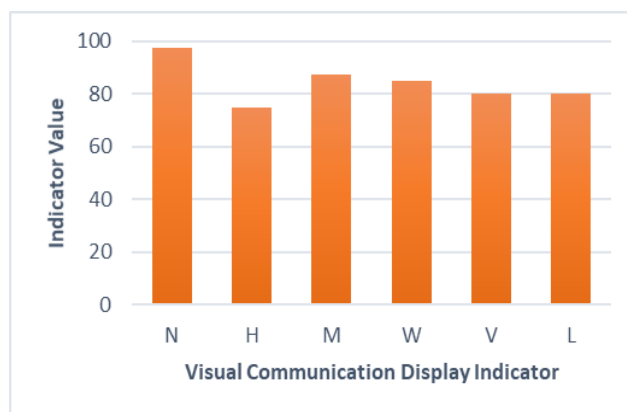


Fig. 3. Visual communication display

Based on Figure 3, the static fluid e-module obtains visual communication display values varying from 75 to 97.5. The value of the visual communication display for each component can be categorized as very good and good for letter display indicators. The visual communication display in the static fluid e-module can make it easier for students to run the e-module with a clear navigation display, legible display of letters, media to help learning and proportional color combinations.

The third component is learning design. The learning design component consists of 8 indicators, namely 1) title (JD), 2) KI and KD (KK), 3) learning objectives (TP), 4) material (MT), 5) sample questions (CS), 6) exercises (LT), 7) constituent (PY), 8) reference (RF). Validation values are placed on the x-axis and for each indicator of the assessment items are placed on the y-axis. The results of the e-module design analysis are shown in Figure 4.

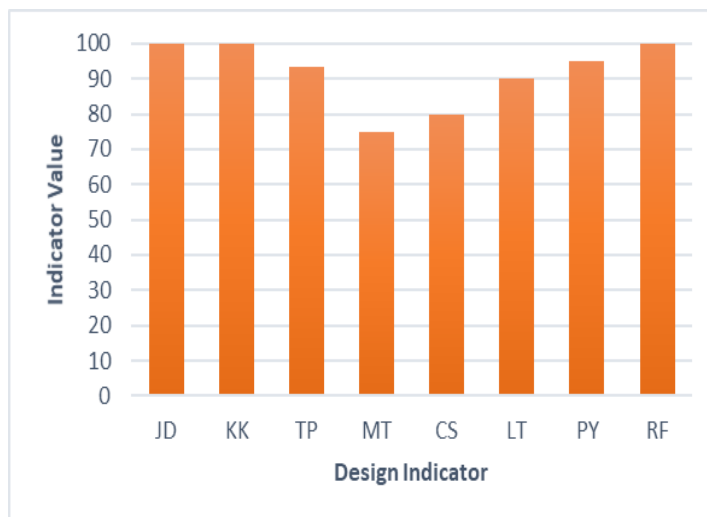


Fig. 4. Design e-modul

Based on Figure 4, the static fluid e-module obtained a design value varying from 75 to 100. Overall, the appearance of the e-module design was in the very good category and for the material design in the good category. The static fluid e-module is in accordance with the basic competencies in the 2013 curriculum and the GPA is described according to the basic competencies. The static fluid e-module contains material, sample questions and exercises that support learning.

The fourth component is the use of software. The software utilization component consists of 3 indicators, namely: 1) interactivity (feedback from the system to users), 2) supporting software, 3) originality. Validation values are placed on the x-axis and for each indicator of the assessment items are placed on the y-axis. The results of the analysis of the use of e-module software are shown in Table 4.

Table 4. Utilization of Software

Indicator	Utilization of software
Interactivity	80
Support Software	90
Originality	90

Based on Table 4, the static fluid e-module utilizes software in the manufacture and use of e-modules. The use of the software is assessed to vary between 80 and 90. The interactivity indicator scored 80 indicating that the static fluid e-module can be an interactive medium for students and teachers. Supporting software used in making e-modules are Ms.Word, youtube, google form and professional flip pdf. The e-module originality indicator is the e-module created by the researcher. Overall, the use of software in e-modules is in a very good category. Utilization of software in e-modules can make it easier for users to use static fluid e-modules.

The fifth component is the STEM assessment. STEM assessment consists of science (SC), technology (TC), engineering (EG) and mathematics (MA). Validation values are placed on the x-axis and for each indicator of the assessment items are placed on the y-axis. The results of the STEM value analysis on the e-module are shown in Figure 5.

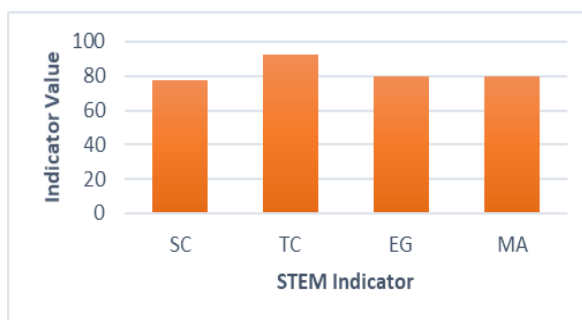


Fig. 5. STEM indikator

Based on Figure 5, the static fluid module obtained STEM values varying from 77.5 to 92.5. The science indicator got a score of 77.5 stating that science in the e-module was in a good category. The technology, engineering and mathematics indicators are worth above 80, so it can be said to be in the very good category. Overall, the static fluid e-module contains STEM indicators well.

Based on the value of each indicator on the validation sheet, the average value of each component of the assessment can be determined. The assessment components include material substance (SM), visual communication display (KV), learning design (DP), software utilization (PS) and STEM assessment (PT). Validation values are placed on the x-axis and for each indicator of the assessment items are placed on the y-axis. The results of the validation component analysis of the e-module are shown in Figure 6.

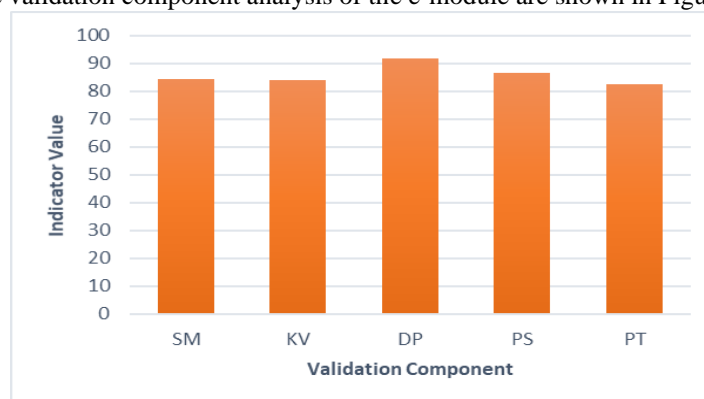


Fig. 6. Komponen validasi e-modul

Based on the data analysis in Figure 6, it can be explained that the value of each component varies with the lowest value of 82 and the highest value of 91. The value of the validation test results according to experts on the static fluid e-module can be determined by finding the average value of all assessment components. The average value of the STEM integrated static fluid e-module validation results according to experts is 85.87 which is in the very good category. The results of the validation data analysis of the static fluid e-module stated that the e-module can be used by students as a learning resource in learning physics. The STEM-integrated static fluid e-module is used as a learning resource that attracts students' attention with the advantages of an electronic module that can be used any time and where students are through their electronic devices. This STEM-integrated static fluid e-module makes it easy for students to access learning resources with module content that is in accordance with the basic competencies of static fluid.

The validity of the STEM-integrated static fluid e-module was assessed by 5 experts by reviewing four components, namely material substance, visual communication display, learning design, and software utilization. The validation instrument contains integrated STEM components according to the needs of the research. The e-module is said to be valid if it meets the standard value of the validation component. The validation value obtained is in the good category, and can be used by students as a learning resource.

Improvements to the e-module were carried out in accordance with the validator's comments and suggestions. Improvements to e-modules include; 1) Writing instructions for using a professional flip builder in the form of menus and buttons, 2) The STEM components of the e-module are not yet clear, 3) The mathematics component has not seen a decrease in formulas, 4) Evaluation of the e-module has not covered all aspects of STEM, 5) Objectives Learning in e-modules does not yet refer to learning indicators, 6) References to images and videos are not visible, 7) Virtual experimental activities on STEM integrated static fluid e-modules do not yet exist, 8) Use of words in e-modules needs to be corrected accordingly. with EYD guidelines, 9) The font size on the e-module is too small. Improvements made are increasing the font size so that students use the e-module efficiently. The improvement of this e-module aims to make the e-module valid in its use. After making improvements to the e-module, the static fluid e-module will be tested on students in the use of the STEM integrated static fluid e-module.

The research conducted has several limitations so that solutions are needed to overcome them. The first limitation is that the STEM integrated static fluid e-module only contains material about static fluids. This is due to the limited time of researchers in making e-modules for only one semester. The solution to this limitation is that e-modules are developed for all materials so that physics learning has many sources so that students can improve their learning outcomes. The second limitation is that the research stage is carried out until a small-scale product trial. The product trial phase was carried out for two classes, namely the experimental class and the control class. This is due to the very short research time. The solution to this limitation is to conduct product trials on a larger scale in order to find out the validity of the product better.

IV. CONCLUSION

Based on the results of research that has been carried out to test the validity of the STEM-integrated static fluid e-module in improving student learning outcomes, it can be said to be valid. Analysis of the data from the validation results using the observation sheet instrument. The results of the validation of the STEM integrated static fluid e-module are 85.87 for each assessment component. This states that the STEM-integrated static fluid e-module is valid to be used in improving student learning outcomes for class XI SMA..

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