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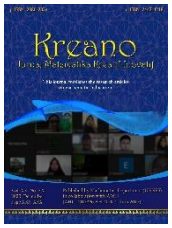

Development of Phet Simulation-Based Mathematics Logic E-Modules in Increasing Students' Mathematical Reasoning Ability

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Abstract

This research is represented through digital teaching with online learning simulations used by SMK teachers in learning mathematical logic that has not improved students' mathematical reasoning abilities. This study aims to describe the feasibility, attractiveness, and effectiveness of the PhET simulation-based mathematical logic e-module in improving students' mathematical reasoning abilities. This research method is the R and D. The research subjects were students of SMK Koperasi Pontianak majoring in Multimedia. Research data were collected using indirect communication techniques and measurements with data collection tools in the form of expert validation sheets, student and teacher response questionnaires, and test questions. Based on the results, it can be concluded that the e-module of mathematical logic with PhET simulation at the valid criterion, very interesting and effective. The results of this study can be implemented in the process of learning mathematical logic digitally through PhET simulation learning to improve students' mathematical reasoning abilities.

Keywords: *e-module;* mathematical *reasoning ability; PhET simulation.*

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Abstrak

Penelitian ini direpresentasikan melalui bahan ajar digital dengan simulasi pembelajaran online yang digunakan oleh guru SMK dalam pembelajaran logika matematika belum meningkatkan kemampuan penalaran matematis siswa. Penelitian ini bertujuan untuk mendeskripsikan kelayakan, kemenarikan dan keefektifan dari e-modul logika matematika berbasis PhET simulation dalam meningkatkan kemampuan penalaran matematis siswa. Metode penelitian ini adalah metode R and D. Subjek penelitian adalah siswa SMK Koperasi Pontianak tepatnya jurusan Multimedia. Data penelitian dikumpulkan menggunakan teknik komunikasi tidak langsung dan pengukuran dengan alat pengumpul data berupa lembar validasi ahli, angket respon siswa dan guru serta soal tes. Berdasarkan hasil penelitian dan pembahasan, dapat disimpulkan bahwa e-modul logika matematika dengan PhET simulation pada tingkat kriteria valid, sangat menarik dan efektif untuk menyelesaikan kesulitan pada siswa khususnya pada materi logika matematika. Hasil penelitian ini dapat diimplementasikan pada proses pembelajaran logika matematika secara digital serta melalui simulasi pembelajaran PhET simulation untuk lebih meningkatkan kemampuan penalaran matematis siswa.

INTRODUCTION

The reasoning process contributes in the form of the role of mathematics. Reasoning is a skill to solve a problem. Kusumawardani et al (2018), students in mathematics must be able to reason in solving problems through a logical process and critically, even in arithmetic. In addition, in social life the importance of the role of mathematics is very important. Mathematics can make people think logically, objectively, analytically, critically, and creatively when solving problems they face (Tsany et al., 2020). A discovery ability to find the truth is called reasoning. In terms, logic is a science that regulates human thought processes so that the results put forward can reach the truth (Suharto & Chotimah, 2018). Patterns of thinking logically, analytically, and critically are closely related to reasoning abilities (Putri et al., 2019). aspects of reasoning ability play an important role so that every student must have it as a criterion that must be developed to improve the mathematics learning process (Permatasari & Marlina, 2022). Reasoning ability plays an important role so that every student must have it as a criterion that must be developed to improve the mathematics learning process (Gustiadi et al., 2021; Konita et al., 2019). Mathematical reasoning ability is a form of thinking (Ariati & Juandi, 2022). Furthermore, Sumartini (2015) added that submitting conjectures and then compiling evidence and even manipulating the mathematical problems themselves so that students can draw conclusions correctly and precisely which can be obtained through mathematical reasoning. To do this, a reasoning process is needed through students' mathematical reasoning abilities.

Based on information obtained through interviews with one of the mathematics teachers at the SMK Koperasi Pontianak where he said that the mathematical reasoning abilities of students majoring in Multimedia were still low, especially in mathematical logic material. He also said that the teaching materials or media used in schools only use textbooks and student worksheets (LKS) which are usually sold on the market and have never used digital-based learning modules that can be accessed anywhere and anytime, resulting in a lack of independence in student learning making the students' mathematical reasoning abilities themselves does not develop as expected.

Truly, the low categorization was found in mathematical reasoning abilities, including: 1) research by Rismen et al (2020) found that students' reasoning and communication were not good, 2) Khaeningsih (2020) concluded that low criteria were covered in students' mathematical reasoning abilities, and 3) Asdarina & Ridha (2020) concluded that the very low

category is still fully held by reasoning abilities in working on questions equivalent to PISA. Some of these studies indicate that mathematical reasoning skills need to be improved. This is reinforced by the results of interviews with teachers at the SMK Koperasi Pontianak which have been described previously showing that the mathematical reasoning abilities of students in the Multimedia major are still low. One solution that can be offered is through the design of learning media in the form of e-modules where these teaching media can help students improve their mathematical reasoning abilities independently because they are not explored optimally while at school.

Anwar (Furqan et al., 2016) suggests that the learning material is systematically arranged and the content is interesting, even the use of methods and self-assessment in order to achieve the expected abilities. Herawati & Muhtadi (2018) stated that a module that contains text, images, or both is called an e-module, are simulated, and are suitable for use in learning in digital form. The module is a source of information that is empowered by students in order to add knowledge and motivation in learning in the learning process in class (Sa'diyah, 2021). In learning, the addition of simulation is suitable to be paired with e-modules.

Along with the development of the technological era and conditions for distance learning, modules in digital form (e-modules) are one of the learning media that can be used in learning which are present as an adaptive form of ordinary modules used during direct learning (Inanna et al., 2021). Currently, many electronic modules have been developed, or commonly known as e-modules (Seruni et al., 2019). Modules in digital form that run through a computer device so that they can display text, animation, images, and videos are known as e-modules. Advances in technology have also made it possible for e-modules to be displayed via smartphones (Laili et al., 2019). A theoretical presentation in digital form that can be used with electronic devices, namely Android and IOS, PCs, and even laptops is called an e-module (Saputra et al., 2022; Wulandari et al., 2021). In addition, one of the efforts to make modules more attractive to students is to make modules digitally with the aim of being used as an interactive learning media by inserting animations, images, audio and video (Sidiq & Ajuah, 2020; Widiana & Rosy, 2021). E-Modules will also be useful in increasing the effectiveness of free access to the learning process during (Fikri, 2022).

Based on the results of the analysis and summary of the use of variables from previous research scientific journal articles (Fikri, 2022; Herawati & Muhtadi, 2018b, 2018a; Saputra et al., 2022; Seruni et al., 2019; Sidiq & Ajuah, 2020; Widiana & Rosy, 2021), it turns out that the development of mathematical logic e-modules with PhET simulations that focus on students' mathematical reasoning abilities has never been carried out so that they become new variables and indicators in this study.

PhET Simulation is a simulation created by the University of Colorado where the scope includes physics, biology, chemistry, and mathematics for the benefit of class or individual learning. Emphasis on the relationship between phenomena in real life and the science that underlies them, support in the process of approaching interactively and constructively, providing feedback, and even providing a creative workspace called PhET Simulation (Finkelstein, 2006). The advantage possessed by PhET simulation is that it helps students understand the lessons conveyed (Saregar, 2016).

Several studies using PhET simulations include: 1) Fithriani et al (2016) found

that students' thinking skills increased through PhET simulation media, (2) Mursalin (2013) concluded that minimizing student misconceptions was obtained from the PhET simulation model assisted by worksheets, (3) Wiravanjava (2017) stated that the results of research conducted through the application of PhET simulations showed a significant increase in critical thinking skills as student learning outcomes. Based on this research, the PhET simulation tool can be used as an alternative medium suitable for students to learn and support students' mathematical reasoning abilities.

Simulation allows students to participate in virtual worlds and application of their knowledge, thoughts, and skills. In addition, simulation can guide students to acquire their reasoning abilities and stimulate students' interest to be involved in discoveries requiring students' reasoning. The formation and transfer of skills in knowledge is focused on students to implement PhET simulations. According to Oktaviana & Prihatin (2020) concluded that by applying the PhET simulation-based mathematical logic practicum module has a positive effect on students' mathematical reasoning. In addition, Prihatin & Oktaviana (2021) added that students' mathematical reasoning increased after being given learning with PhET simulation-based mathematical logic practicum guide. Based on the previous explanation, this indicates that an electronic-based module (e-module) based on PhET simulation has not been applied to students with the aim of seeing their mathematical reasoning abilities in mathematical logic material.

This development study was carried out with reference to the research strategic plan on the topic of developing innovative learning-based teaching materials with products developed by mathematical logic e-modules based on PhET simulation. For this reason, researchers are trying to develop mathematical logic e-module based on PhET simulation of mathematical reasoning abilities.

METHOD

This research uses the type of R&D. Development is the process of making and testing products and their effectiveness (Sugiyono, 2016). The research design using the Borg and Gall model simulated in Figure 1.

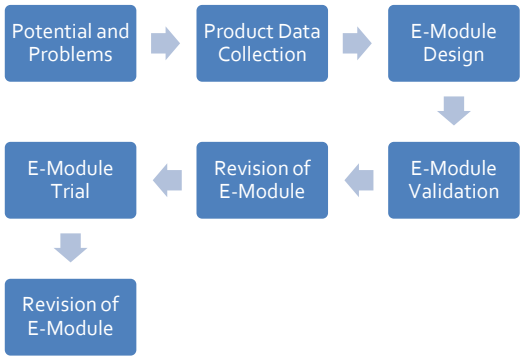

Figure 1. Borg and Gall Research Design

The stages in developing an e-module product based on PhET simulation are described as follows: (1) the potential and problem stages are carried out by exploring the problems encountered in the field. Researchers conducted pre-observations by conducting interviews and providing questionnaires related to the need for this product development; (2) the data collection stage is carried out by data collectors in product development. This data is collected from previous studies, how to use PhET simulation and materials in making e-modules; (3) the e-module design stage is the initial stage of designing e-modules before being tested in the field. Apart from that, instruments were also made; (4) the validator validates the e-module which then provides suggestions as a revision of the e-module itself. This step uses

an expert validation sheet as a means of collecting data validated by the validator; (5) the next stage is field trials. Testing is done after the e-module is valid or feasible. Trials were conducted conduct an analysis of students' mathematical reasoning abilities as well as to see how practical the product is as a learning medium in class. If there are various deficiencies in the learning process at the product trial stage, revisions can be made to the product.

The subjects in this study were experts and students. The experts in question are media and material experts. Two lecturers in technology and information education are media experts. Media experts assess the appearance of the e-module regarding the composition of the content, coloring, layout, and images in the media. While the material experts are two mathematics education lecturers. Material experts provide an assessment of the presentation and suitability of the material in the product. Students are subjects in product trials. The student is a SMK student majoring in multimedia to be exact. Students who become product trials are taken based on the teacher's consideration by looking at the cognitive abilities of students.

The data collection technique used was measurement techniques and indirect communication. The data collection tools used were expert validation sheets, questionnaires, and mathematical reasoning ability test questions. The data analysis technique is to determine validity and attractiveness with the criteria of product validity and practicality and to calculate the effectiveness of e-module products based on PhET simulation with paired sample t-tests.

RESULTS AND DISCUSSION

Results

This research was conducted using ten (10) stages of the Borg and Gall development model that have been modified only up to the seventh step, namely product revision. This research develops a product that focuses on students' mathematical reasoning abilities in the form of mathematical logic e-modules with PhET simulations. The process that has been carried out in this study is the first, namely the potential and problems where researchers find a potential that students have, namely students in class XI of SMK Koperasi Pontianak have high creativity but the teaching materials are not yet available. Another potential is that with the existence of printed media whose contents are full of pictures and colors make students become interested in learning mathematics. Researchers conducted interviews and obtained results, the basic problems that occur in class XI students of SMK Koperasi Pontianak, in the process of learning mathematics, namely with students having difficulty understanding mathematical logic material, students are lazy to read textbooks, so they do not understand textbooks what they have thus requires simplification result in a better understanding of lessons. Another problem that arises is the limited learning media that can be explored in the mathematics learning process, and the teacher's learning methods lack the creativity of SMK Koperasi Pontianak students, resulting in a lack of enthusiasm for student learning.

The second is data/information collection where the researcher collects information in the form of supporting theory for the media to be made. Collect data that can be used as reference material or complementary data through interviews with teachers regarding problems in class,

Front cover *Back Cover*

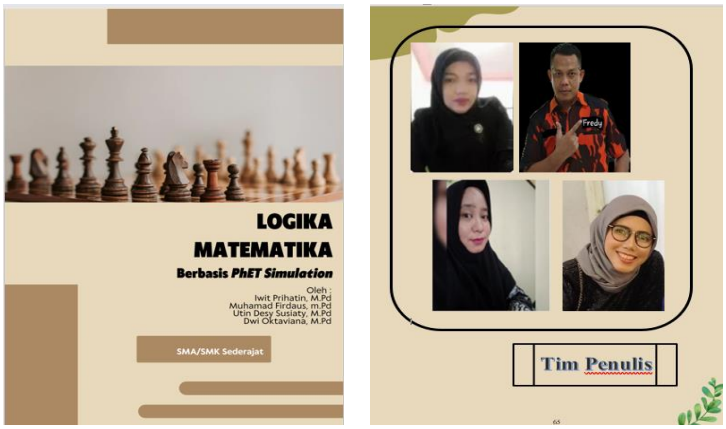

Figure 2. *Front and Back Covers of Mathematical Logic E-Modules with Phet Simulation*

as well as plans for making mathematical logic e-modules with PhET simulation. In addition, it was carried out by conducting a literature review of various existing literature. The researcher determined that the resulting learning media was in the form of learning media that refers to the 2013 curriculum, namely mathematical logic e-modules with PhET simulations. The results of observations along with interviews with mathematics teachers in schools related to learning mathematical logic turned out to be the difficulties experienced by students in solving mathematical logic problems.

The third is product design where the product design begins with designing the cover as well as the content design of the mathematical logic e-module with PhET simulation which will be developed. The cover view of the mathematical logic e-module with PhET simulation is shown in Figure 2.

The fourth is the design validation stage through three (3) people as validators with the aim of seeing the validity of the mathematical logic e-module product with the designed PhET simulation. The validation results are used to revise or improve the mathematical logic e-module with the PhET simulation that was developed prior to being tested. Table 1 shows the results of product validation.

Table 1. Validation Results

Research Instruments	Validators			Average	Criteria
	I	II	III		
Material	3,64	3,21	3,66	3,50	Valid
Mathematical logic e-module with PhET simulation	3,67	3,41	3,59	3,56	Valid
Questionnaire (Teacher)	3,68	3,20	3,68	3,52	Valid
Questionnaire (Students)	3,68	3,20	3,68	3,52	Valid
RPP	3,9	4	3,9	3,93	Valid
Evaluation or Posttest	3,76	3,76	3,52	3,68	Valid

Table 1 shows that the average score of the material expert validation results by the three validators is 3.50 with valid criteria, so further calculations can be continued which are obtained from the calculation results of the overall data validation of the material experts from the three validators. The validation results of the mathematical logic e-module with PhET simulations by the three validators have an average value of 3.56 with valid criteria obtained from the calculation results.

The average score of the validation results of the questionnaire (teacher) is 3.52 with valid criteria on the overall data of media experts from the three validators, the average score of the validation results of the questionnaire (students) is 3.52 with valid criteria, and the average score of the lesson plan validation results is 3.93 with valid criteria, then the result of

completing the posttest questions is 3.68 with valid criteria.

After the initial product design has been validated by experts, deficiencies can be identified. These deficiencies will then be revised in the design, which is the fifth step, namely product revision.

After the mathematical logic e-module with PhET simulation has been validated and revised, the next step is to carry out the sixth step of product testing. The trial phase carried out by the researcher was a limited trial phase, because circumstances did not allow carrying out trials on a large scale. The school referred to in this study is the Pontianak Cooperative Vocational High School. This trial aims to see the attractiveness and effectiveness of the mathematical logic e-module with PhET simulation as a learning medium developed in mathematical logic material. The attractiveness of the limited product trial shown from the results of both teacher and student response questionnaires, then the effectiveness of the mathematical logic e-module with PhET simulation is shown from the results of the posttest.

The test results are as follows: (1) the interest in the mathematical logic e-module with the PhET simulation is shown from the results of the teacher and student response questionnaires. Then the results of the teacher and student response questionnaire to the mathematical logic e-module with PhET simulations.

Table 2. Results of the Teacher and Student Response Questionnaire

Respondents	Total Score	Percentage (%)	Criteria
Teacher	72	3,39	Very interesting
Student	49 (Highest)	3,92	Very interesting
	44 (Lowest)	3,52	Very interesting
	46,5 (Avg)	3,72	Very interesting

Table 2 shows that the results of the teacher's response questionnaire on the mathematical logic e-module with PhET simulation were 3.39 very interesting criteria, then the results of the student response questionnaire on the mathematical logic e-module with PhET simulation with an average score of 3.72 very interesting criteria.

Furthermore, (2) the effectiveness of the mathematical logic e-module with PhET simulation obtained from the results of the pretest and posttest completed by students of class XI SMK Koperasi Pontianak in accordance with students' mathematical reasoning abilities, which then carried out a hypothesis test with the aim of knowing that there was an increase in students' mathematical reasoning abilities after applying learning with mathematical logic e-modules with PhET simulations. The results of the pretest and posttest data of students' mathematical reasoning abilities were normally distributed.

Therefore, the requirements for normality in the paired sample t-test have been fulfilled. Then the hypothesis test was carried out and Sig. < 0.05 (0.000 < 0.05) which this means that there is a significant increase in students' mathematical reasoning abilities after applying learning with mathematical logic e-modules with PhET simulations. In the hypothesis test, it was found that there was an increase in students' mathematical reasoning abilities through the mathematical logic e-module with PhET simulation, it is said that the e-module is effective. The seventh step of the development process is product revision where the researcher makes the final revision obtained based on the test results data, resulting in the final product.

Discussion

If the learning source attracts the respondent to read and is delivered in a very interesting and varied way, it will make the respondent more interested and motivated and will develop his creativity and providing an understanding of the material to be received is an opportunity given to respondents. The development of learning media in this study, namely e-modules of mathematical logic with PhET simulations focused on students' mathematical reasoning abilities. Compulsory learning material studied by students at each level of the education unit is mathematics. Mathematics lessons are a systematization of logic, so that it can be said that logic is a category of pure mathematics (Prihatin et al., 2022). A science that conveys coherent conclusions and specifically develops the use of mathematical methods and uses special symbols so that a person may avoid multiple meanings in the use of everyday language is called symbolic logic (Rahmawati et al., 2021).

The results obtained from this development research are a mathematical logic e-module with PhET simulation in mathematical logic material for class XI SMK students that is valid, interesting, and effective. The results of the validity assessment of the three validators in the mathematical logic e-module with PhET simulation obtained 3.56. Based on the results of the attractiveness of the mathematical logic e-module with PhET simulation, teacher, and student response questionnaires respectively 3.39 and 3.72. The effectiveness of students' mathematical reasoning abilities through hypothesis testing with the t test, there is a significant increase in students' mathematical reasoning abilities after getting learning with the e-module of mathematical logic with PhET simulation so that it is categorized as effective.

The process of developing mathematical logic e-modules with PhET simulation in this study uses the Borg and Gall research design developed by Sugiyono (2016) which has stages namely identifying potentials and problems, conducting data collection, making product designs, validating designs, revising designs, testing products, revising products, testing product usage, revising products, and mass-producing. The potential and problem stage aims to collect a problem based on facts in the field. The data collection stage is collecting various information obtained as material for planning a particular product in the hope of overcoming the problem.

The results of collecting information obtained from interviews and observations are an important reference and foundation in making mathematical logic e-modules with PhET simulation in mathematical logic material, so that it can assist teachers in explaining mathematical logic material, as well as being an alternative of learning resources in the teaching and learning process with the aim of students not feeling bored during the learning process. The design validation stage is a process of conducting an assessment to see whether a rational product design will be effective or not in terms of material and media. The revision stage was carried out to find out the advantages and disadvantages of the product being designed. This product trial phase aims to obtain information whether the mathematical logic e-module with PhET simulation is effective. The product revision stage aims to improve the suggestions given by students. The usage trial phase aims to obtain information whether the mathematical logic e-module with PhET simulation is effective or not. The product revision stage is carried out to find out the weaknesses and deficiencies of the product de-

signed and revised based on the validator's suggestions and comments. The mass production stage aims to determine whether the product that has been developed is effective or not. However, in this study it did not reach the mass production step due to time and cost constraints and this research was only intended to solve the problems that existed at the Pontianak Cooperative Vocational High School, so it only reached the seven step stage.

The development in this study focused on e-modules based on PhET simulations. The development process is the e-module that has been designed, while for PhET the simulation uses a virtual laboratory application, namely Physics Education Technology (PhET) simulation (Saregar, 2016). This simulation media was developed by Katherin Perkins et al from the University of Colorado, United States. This PhET simulation is made in Java or Flash so that it can be run directly from a website using a standard web browser (Rizaldi et al., 2020).

Borg and Gall's design has the objective of knowing the validity, attractiveness, and effectiveness of mathematical logic e-modules with PhET simulations. This is in line with Nieeven's opinion Mustaming et al (2015) who said that the quality of learning tools is based on criteria which include three aspects, namely: validity, practicality, and effectiveness.

Mathematical logic e-modules with PhET simulation must first pass validity so that they can be tested on a limited basis through the results of validation by the validator, then the attractiveness and effectiveness are determined based on the results of the response questionnaire and the results of the pretest and posttest. The validity of the mathematical logic e-module with PhET simulation was obtained from the validation results by the three validators. E-module mathematical logic with PhET simulation is declared valid with an average validity score of 3.56. The results of the validation are in the form of comments and suggestions on the mathematical logic e-module with the PhET simulation designed and research instruments. Before being tested on a limited basis the mathematical logic e-module with PhET simulation had to go through the first stage of revision is carried out based on the validation results, comments, and suggestions from the validator.

After completing validation, revising the product based on input and suggestions by media and material experts is the next step that must be carried out. Furthermore, conducting product trials, product trials were carried out to determine the attractiveness and effectiveness of the mathematical logic e-module with the developed PhET simulation. To find out effectiveness and interest can be seen from the results of trials using the product through the results of student and teacher response questionnaires, as well as the results of the pretest and posttest. The researcher gave student response questionnaires and pretest and posttest questions directly to students, which students had to do in the trial class, limited to the third meeting.

The provision of materials and questionnaires was carried out face-to-face to each Pontianak Cooperative Vocational School student. Questionnaires are distributed directly and must be done by students within a specified time limit. Closed questionnaire is the instrument in this study. Closed questionnaires are questionnaires that have provided alternative answers; thus the respondents' answers are in accordance with the limits of the answers given.

In accordance with the results of the student response questionnaire given in the limited trial class, which was distributed directly and worked on by students,

the average practicality index percentage was obtained at 3.72 with very attractive criteria while the attractiveness index results from the teacher's response questionnaire were 3.39 with the criteria very interesting. Obtain the results from the teacher and student response questionnaire, the mathematical logic e-module with PhET simulation can be said to be very attractive to teachers and students. There are differences in criteria between teachers and students based on teachers who do not directly apply the mathematical logic e-module with PhET simulation but are carried out by researchers. This research is in line with the results of research by (Kartika, Sanapiah, & Julaingkary, 2017; Kartika, Sanapiah, & Juliangkary, 2017) who argued that the existence of a mathematical logic learning module for students greatly assists teachers in carrying out their learning activities, because the modules developed are usually adapted to the characteristics of the students themselves and the modules developed are appropriate for use in the learning process at school.

The presentation of the material in the mathematical logic e-module with PhET simulations is delivered in a clear and interesting way because it is equipped with appropriate pictures and colors. The mathematical logic e-module with PhET simulation in this study is of medium size and can be taken anywhere so that it is more practical to study anywhere, anytime and can assist students in independent learning because it can be accessed on their respective devices. This is because the students' response to the mathematical logic e-module with PhET simulation was very satisfying because students feel they understand the material contained in the mathematical logic e-module with PhET simulation more practically and it is more practical to learn anywhere and anytime.

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Based on the results of the pretest and posttest obtained during the limited trial, it showed that students' mathematical reasoning abilities increased more after using the mathematical logic module with PhET simulation. Referring to this, it is obtained that the e-module of mathematical logic with PhET simulation on mathematical logic material students understand the essence of the material presented and can complete the mathematical logic material well. The results of this study are directly proportional to the research conducted by Herawati & Muhtadi (2018) where it was found that the application and use of e-modules are generally categorized as proper and receive positive responses from students. There is a difference between the test results before using the e-module and the test results after using the e-module. Furthermore, research conducted by Sa'diyah (2021) found that digital flipbook-based e-modules are included in the category of valid and theoretically feasible.

Implication

The implications of this research so that it can become a point of view for future readers and researchers include: (1) the mathematical logic e-module with PhET simulation developed in this study can be continued by other researchers up to the tenth step, namely mass production on a wider scale; (2) the mathematical logic e-module with PhET simulation that is being developed still needs to be refined with further trials up to the tenth step so that the quality of the mathematical logic E-module with PhET simulation is truly tested in terms of its utilization; (3) before developing a product, look for as many references as possible related to the product to be developed.

Limitation

Limitations in conducting research include this research not being continued until the last stage, namely the dissemination stage. This is due to inadequate time and finances. In addition, researchers also do not master design other than using flip book applications, so researchers design e-modules only using flip book applications, both in terms of cover, title and even content. Furthermore, in this study, the researcher only examined one school and had not researched all schools or one area.

CONCLUSION

In connection with the results of the presentation related to the research and discussion, the conclusions that can be drawn are developments mathematical logic e-modules with PhET simulation in mathematical logic materials for class XI students of the SMK Koperasi Pontianak using The Borg and Gall model development plan consists of seven (7) steps, namely: finding potentials and problems, collecting data, conducting product designs, validating designs, revising designs, testing products, and revising the final product. The results of the formulation of the sub-problems that have been determined are as follows: (1) the results of the analysis of the three validators' validation sheet on mathematical logic e-modules with PhET simulations at the validity level with valid criteria, then the mathematical logic e-modules with PhET simulation can be used or can be tested; (2) the level of attractiveness with very interesting criteria and student responses with very interesting criteria. based on the analysis of filling out the questionnaire by the teacher and students, the e-module of mathematical logic with PhET simulation can be said to be attractive to teachers and students; (3) based on pretest and posttest analysis that has been completed by students in the limited trial stage, it is found that learning with mathematical logic e-modules with PhET simulation in class XI students of SMK Koperasi Pontianak can improve students' mathematical reasoning abilities, it can be concluded that logic e-modules mathematics with PhET simulation which was developed effectively to solve difficulties in class XI students of the SMK Koperasi Pontianak, especially in mathematical logic material.

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