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Development inovatif statistic e-modul based multiple representation

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Abstract: Mathematical thinking in problem-solving is an important goal of learning mathematics. The ability to use various ways of presenting mathematical concepts (multi-representation) is an important aspect of mathematical thinking. In its implementation, students experience problem-solving failures because of difficulties in making changes from one representation to another. This fact can be seen from the initial observations in statistics class, which showed that out of 37 students, only 12 students were successful in solving statistical problems because they could change verbal and graphic representations to symbolic ones correctly. Meanwhile, 17 out of 25 students failed because they did not understand the problems displayed in graphic form. To overcome this problem, statistical module development research has been carried out by applying the SPSS practice video barcode innovation. The development method uses a modified 4-D model, namely define, design, and develop. Modifications are carried out by eliminating the dissemination stage due to limited time and research costs. Data collection techniques in this study used a questionnaire. The data obtained are qualitative and quantitative. The results showed that the module developed was included in the very feasible criteria, in terms of content feasibility at 85.78%, language feasibility at 88.61%, presentation feasibility at 84.82%, and graphic feasibility at 84.72%. The results of the trial were limited to 37 students who received a positive response of 85,63% so the statistics module was suitable for use as teaching materials.

Keywords: statistics e-module; innovative; multiple representation

Pengembangan e-Modul Statistika Inovatif Berbasis Multiple Reprsentasi

Abstrak: Berpikir matematis dalam pemecahan masalah merupakan tujuan penting pembelajaran matematika. Kemampuan menggunakan berbagai macam cara dalam menampilkan konsep matematika (multi representasi) merupakan aspek penting dalam berpikir matematis. Dalam implementasinya, mahasiswa mengalami kegagalan pemecahan masalah karena kesulitan dalam melakukan perubahan dari satu representasi ke representasi lain. Fakta ini terlihat dari observasi awal di kelas statistika, yang menunjukkan dari 37 mahasiswa, hanya 12 mahasiswa yang sukses memecahkan masalah statistika karena dapat mengubah representasi verbal dan grafik menuju simbolik dengan tepat. Sedangkan 17 dari 25 mahasiswa gagal karena tidak memahami masalah yang ditampilkan dalam bentuk grafik. Untuk mengatasi masalah tersebut maka telah dilakukan penelitian pengembangan e-modul statistika dengan menerapkan inovasi barcode video praktek SPSS. Metode pengembangan menggunakan model 4-D termodifikasi, yaitu *define*, *design*, dan *develop*. Modifikasi dilakukan dengan mengeliminasi tahap *disseminate* karena keterbatasan waktu dan biaya penelitian. Teknik pengumpulan data dalam penelitian ini menggunakan angket. Data yang diperoleh adalah data kualitatif dan kuantitatif. Hasil penelitian menunjukkan modul yang dikembangkan termasuk dalam kriteria sangat layak, ditinjau dari kelayakan isi sebesar 85,78%, kelayakan bahasa sebesar 88,61%, kelayakan penyajian sebesar 84,82%, kelayakan kegrafikan sebesar 84,72%. Hasil ujicoba terbatas pada 37 lima mahasiswa mendapat respon positif sebesar 85,63% sehingga modul statistika layak digunakan sebagai bahan ajar.

Kata Kunci: e-modul statistika; inovatif; multi representasi

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INTRODUCTION

Mathematical thinking in problem-solving is an important goal of learning mathematics (NCTM, 2003; Santia, et al., 2019). The ability to use various ways of presenting mathematical concepts (multi-representation) is an important aspect of mathematical thinking (Santia, et al., 2021). This is because the concept of representation is one of the psychological terms used in learning mathematics to explain important phenomena about thinking. Therefore, when someone thinks about a mathematical situation, that person has done a mathematical representation of Biber (2014). In statistical material, various representations are displayed in presentation problems as well as parameter and statistical analysis. Among them are representations of mathematical symbols, verbal representations in the form of written text, and visual representations in the form of tables, graphs, and diagrams. Referring to the diversity of mathematical symbols, students must be able to use the diversity of representations (multi-representation) in translating the mathematical concepts contained in these symbols (Mahmud & Pratiwi, 2019). In other words, students' multi-representation ability supports statistical problem-solving abilities.

Multi-representation is the embodiment of abstract concepts or ideas in several forms or ways (Santia, 2018). According to Santia et al. (2019), the use of multi-representation aspects is very much needed by lecturers in the learning process in the classroom. Lecturers can design learning models by implementing multi-representation aspects so that the effectiveness of the learning models used increases. In addition, students' skills in using numbers and mathematical symbols to solve practical problems in everyday contexts can increase.

Regarding the importance of the multi-representation aspect above, it turns out to be contradictory to the facts on the ground which show that there are still many students who have low multi-representation skills. This can be seen from the initial observation which stated that of the 37 students in the statistics course, only 12 students could read the symbols in the SPSS analysis results correctly. Of the 12 students, only 8 students were able to solve statistical problems correctly. In addition, referring to the report (OECD, 2017) it is stated that the ability to use multiple representations in the application of mathematical and scientific literacy in Indonesia is 71% and 60% below the minimum competency. This proves that the ability to use multiple representations affects student competence, especially in problem-solving, which in this case is a statistical problem

To overcome this problem, an innovative multi-representation-based statistical e-module will be developed to develop students' problem-solving skills in statistical material. The innovation that emerged was in the form of complementing existing e-module media by integrating ICT in statistics learning (TPACK). The e-statistics module is equipped with a video barcode on the practice of presenting and analyzing data using SPSS and Ms. excel. With this innovation, students are expected to be able to use content knowledge and digital skills in solving problems that require multiple representations. Based on the description of the background above, the purpose of this study is to develop an innovative multi-representation-based e-module that is valid for use in statistical learning.

METHOD

The development method uses a modified 4-D model, namely define, design, and develop. Modification is done by eliminating the disseminate stage due to the limited time and research costs. Data collection techniques in this study used a questionnaire. The validators of the e-statistics module include material experts as people who are competent in the field of mathematics, especially statistics (ADH), graphic experts as people who are competent in the field of graphics and textbook publishing (LRH.), mathematics learning media experts who are competent in learning technology (AN), and 37 students of Statistics 3C class for a limited trial, because according to Sadiman (2012) small group trials were given to 20-30 people who could represent the target population.

The types of data obtained in this development are qualitative and quantitative data. Qualitative research is more descriptive, the data collected is in the form of words or pictures, so it does not emphasize numbers, while quantitative research is research data in the form of numbers (Sugiyono, 2010). Qualitative data was obtained from a questionnaire reviewed by experts or validators, while quantitative data was obtained from the validation results in the form of a questionnaire validation sheet given to experts, and student response questionnaires which were analyzed using the percentage technique.

Table 1. Interpretation of Feasibility Statistics E-Module

Evaluation (%)	Intepretation Criteria
0 – 20	Very unworthy
21 – 40	Not feasible
41 – 60	Feasible enough
61 – 80	Feasible
81 – 100	Very feasible

Adapted from Khabib (2006)

In this study, there were three research instruments used, namely: 1) a study sheet, 2) a validation questionnaire sheet, and 3) a student response questionnaire sheet. The review sheet and validation sheet were given to the three experts. The validation questionnaire by the three experts was analyzed descriptively and quantitatively. The percentage is obtained based on the calculation of scores according to the Likert Scale (Khabibah, 2006) with a description of the rating scale for expert validation, namely "5" is very good, "4" is good, "3" is quite good, "2" is not good, and “1” is of very bad value. As for the assessment items, the material review and validation sheets were developed based on the criteria for a good e-module assessment, namely self-instructional, self-contained, stand-alone, adaptive, user-friendly, and consistent (Anwar, 2010). Closed questionnaires regarding student responses were analyzed descriptively and quantitatively. The percentage is obtained based on the calculation of the Guttman Scale (Khabibah, 2006) with a description of the rating scale for students' opinions, namely "Yes" with a value of one and "No" with a value of zero. From the results of the student response questionnaire analysis, it can be concluded that the module

is considered feasible or valid to be used if the interpretation is 61%. Then the results of the calculation of the value of the three experts and student responses are interpreted into the categories shown in Table 1. The innovative multi-representation-based statistical e-module is said to be feasible if the percentage of eligibility is 61%.

RESULT AND DISCUSSION

RESULT

This development uses a modified 4-D development model (define, design, and develop), the disseminate stage is not carried out due to time and cost constraints. Defining Stage, at this stage the learning requirements are defined and defined. There are five steps in this stage consisting of front-end analysis which aims to raise and define the basic problems encountered in learning so that it is necessary to develop learning materials for e-statistics modules, learner analysis which aims to to examine the characteristics of students as an illustration for the design and development of statistical e-modules, task analysis which aims to identify tasks in the statistics e-module teaching materials, concept analysis by making concept maps, and specifications the learning objective (specifying instructional objective) is to develop statistical problem solving skills through the development of multiple representations.

Design phase. This design phase aims to design an innovative multi-representation-based statistical e-module. This design phase includes two steps, namely the selection of the module format (format selection) and the initial design of the module (initial design). The module format starts from the front cover of the module to the back cover of the module. The structure of the content of the module includes material described from indicators, practice questions on descriptive statistics and inferential statistics, a summary of the material that has been presented, and statistical evaluation. Designing a module is an activity to design a module model or physical module to make it more interesting and motivate students to learn. The initial design of the module is shown in Figure 1.

Figure 1. *Initial Design*

The development phase aims to produce an innovative multi-representation-based statistical e-module that is feasible. The feasibility of this module is measured through a review containing suggestions or input and validation by experts, namely material experts, linguists, and graphic experts. The effectiveness of the module is measured through the results of student responses after using the e-module obtained from filling out a questionnaire during a limited trial. The e-module review is carried out to obtain input for improving the content of the developed module. Improvements made to the module based on input from material and language experts include 1) the Addition of video examples of normality and homogeneity test questions; 2) There are spelling errors in some words in the e-module, and 3). While the improvements made to the module based on input from graphic experts, among others: 1) The color of the cover is better made more attractive, maintaining the balance of the image, and the background on the cover; 2) The conformity of the e-module format is by ISO standards, and 3) graphic images in each chapter need to be sharpened. The feasibility of the developed module can be seen from the validation results of the experts. The results of the validation can be in the form of a rating scale and suggestions for improvement from each validator. The validation results are in the form of quantitative data that is used as a basis for determining the quality or feasibility of the e-module. The results of the validation analysis of the experts by taking into account the criteria for a good module assessment, namely self-instructional, self-contained, stand-alone, adaptive, user friendly and consistent are described in Table 2.

Table 2. Validation Result

No	Aspect	Persentation (%)	Intepretation
1	Content	85,78	Very eligible
2	Language	88,61	Very eligible
3	Lay out	84,82	Very eligible
4	Graphic	84,72	Very eligible
Average		86,084	Very eligible

Source: The data is processed from the validation sheet

Based on Table 2, the average percentage of the feasibility of the content, presentation, language, and graphics of the teaching materials developed is 86.084% so it can be concluded that the feasibility of the e-module based on the components of the feasibility of content, presentation, language, and graphics are categorized as "very feasible". Furthermore, a limited trial was conducted on 37 students to know the student's responses to the e-statistics module that had been developed. The method of collecting data is by asking students to fill out a response questionnaire. The student response questionnaire contains three criteria including suitability with statistical content, physical presentation, and language. The results of the response questionnaire are described in Table 3.

Table 3. Students Respon

No	Respon Criteria	Respon Percentage (%)	Intepretation
1	Statistic content	85,68	Very eligible
2	Physical	86,70	Very eligible
3	Language	84,52	Very eligible
	Rata-rata keseluruhan	85,63	Very eligible

Source: The data is processed from the respon sheet

Based on Table 3, the overall average percentage of responses to the suitability of statistical content, physical presentation, and language developed is 85.63% so it can be concluded that responding positively to multi-representation-based innovative statistical e-modules.

DISCUSSION

Based on the results of expert validation, the data presented were analyzed using quantitative descriptive analysis techniques, namely by converting quantitative data into percentage form which was then interpreted with qualitative sentences. The content feasibility component is included in the very feasible category with an average percentage of 85.78%. This is because the e-module developed contains concepts and theories that are presented by KI and KD, as well as learning indicators and have met the criteria of self-instructional, self-contained, stand-alone, adaptive, user friendly, and consistent (Herawati & Muhtadi, 2018; Santia, et al., 2017). The presentation feasibility component is included in the very feasible category with an average percentage of 82.45%. This is supported by the presentation of teaching materials that have included all components which include systematic consistency of presentation, coherence of concepts, suitability of illustrations with material, presentation of texts, tables, pictures, and attachments accompanied by references/reference sources, generator of learning motivation at the beginning of chapters, summaries, bibliography, and glossary (Anugrahana, 2019; Sutrisno, 2019). The language eligibility component is categorized as very feasible with an average percentage of 88.61%. This is supported by the language used in the e-module referring to good and correct Indonesian language rules, meaning that all teaching materials must pay attention to the linguistic component according to the aspects in the language feasibility sub-component so that the accuracy of sentence structure and systematic arrangement of the material makes it easier for students to understand. understand the learning material (Depdiknas, 2008). The average percentage of the graphic feasibility component in the e-module layout is 84.72%, so it is categorized as very feasible. This is supported by attractive colors and illustrations of the e-module cover design as well as the e-module content, to clarify the concepts, messages, and ideas conveyed in the e-module. Attractive illustrations plus the right layout can make teaching materials more interesting to study and can motivate students to use the e-statistics module.

This study also aims to determine student responses to the e-statistics module that was developed in terms of the criteria for conformity with solving multi-representation

statistics problems. The overall analysis of the results of the limited trial of e-modules from student assessments obtained an average percentage of 85.63%, then the development of innovative multi-representation-based statistical e-modules was declared "very feasible" to be used in statistics learning.

CONCLUSION

Based on the formulation of the problem taken, the conclusions of the development of an algebra module based on relational thinking skills are: (1) this development produces a product in the form of an innovative multi-representation-based statistical e-module. This development was developed using a modified 4-D model which includes defining, design, and development steps; (2) the feasibility of an innovative multi-representation-based statistical e-module in terms of the feasibility of content, presentation, language, and graphics is very feasible to be used as a statistical teaching material; and (3) student responses to innovative multi-representation-based statistical e-modules are positive with very feasible criteria and proven to help students in solving statistical problems.

forward several suggestions, including: (1) with the existence of this innovative multi-representation-based statistical e-module, it is hoped that educators will pay more attention to students' multi-representation abilities in problem-solving; (2) it is recommended that product developers can then make products with other materials with augmenter reality innovations; and (3) the next developer is expected not only to stop until the developing stage, but can continue with the disseminate stage so that the product is more useful for the wider community.

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