



DEVELOPMENT OF MATHEMATICS STATISTICS E-MODULE ORIENTED ON SCHEMATIC REPRESENTATION

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Abstrak

Penelitian pengembangan ini bertujuan untuk mendeskripsikan pengembangan e-modul statistika matematika I yang berorientasi pada representasi skematis. Tahapan pengembangan meliputi analisis kebutuhan, desain awal produk, prototipe I, validasi, analisis hasil validasi, produk akhir. Subjek dalam penelitian ini adalah mahasiswa program studi pendidikan matematika semester IV. Jumlah mahasiswa yang terlibat adalah 25 mahasiswa. Instrumen yang digunakan dalam penelitian ini meliputi lembar validasi ahli, angket respon dosen dan mahasiswa. Hasil penelitian menunjukkan bahwa e-modul statistika matematika I berorientasi representasi skematis yang dikembangkan dinilai sangat valid berdasarkan validasi responden ahli. Selain itu hasil pengembangan e-modul juga dinyatakan sangat praktis berdasar responden dosen dan mahasiswa dengan rata-rata 80.9%. Berdasar hasil penelitian yang diperoleh dapat disimpulkan bahwa pengembangan e-modul statistika matematika I yang berorientasi pada representasi skematis sangat valid dan praktis digunakan dan memudahkan mahasiswa dalam pembelajaran.

Kata kunci: E-modul; Representasi Skematis; Statistika Matematika

Abstract

This development research aims to describe the development of the mathematical statistics e-module I which is oriented towards schematic representation. The development stages include needs analysis, initial product design, prototype I, validation, analysis of validation results, final product. The subjects in this study were students of the fourth semester mathematics education study program. There were 25 students in total. The instruments used in this study included expert validation sheets, lecturer and student response questionnaires. The results showed that the mathematical statistics e-module I oriented towards schematic representation, which had been developed, was rated as very valid based on the validation by expert respondents. In addition, the results of e-module development were also stated to be very practical based on lecturer and student respondents with an average of 80.9%. Based on the research results obtained, it can be concluded that the development of the mathematical statistics e-module I which is oriented towards schematic representation is very valid and practical to use and makes it easier for students to learn.

Keywords: E-module; Schematic Representation; Mathematical Statistics



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INTRODUCTION

The ability to form representations is one of the standards that must be mastered by students (National Council of Teachers of Mathematics, 2000). By forming representations, students can develop and deepen their understanding of mathematical concepts and relationships (Nizarudin, 2014; Utami et al 2019). In addition, by forming representations it can help students make mathematical ideas more concrete and facilitate reflection (National Council of Teachers of Mathematics, 2000), strengthen students' understanding to construct concepts and solve mathematical problems, especially story problems (Stylianou, 2010). Representation is considered a crucial part of mathematical activity and a key means of grasping mathematical concepts (Cai, 2005; Kaput et al., 2008; Nizarudin, 2014; Fasihah & Qohar, A. (2020)).

Schematic representation is one type of representation that is effective in supporting students' success in solving mathematical problems (Anwar et al., 2019), because with it students can illustrate the problem contents in schematic form (Fagnant & Vlassis, 2013). In addition, by using a schematic representation, students can extract key data and find out the relationships between the information presented in the problem (Anwar et al., 2019; Hegarty & Kozhevnikov, 1999; Hariyani et al., 2023).

In general, the scope of material for the mathematics statistics course includes random variables, distribution functions, joint distribution of random variables, functions of random variables, distribution with random variables. The concepts from the material are also developed in various forms of questions related to problems in everyday life which are presented in the form of word problems. Therefore it really needs students' ability to form schematic representations in mathematical statistics course.



The Covid-19 pandemic which has spread throughout the world requires adaptation, especially in the implementation of learning. Implementation of learning that was carried out during the Covid-19 pandemic was carried out online. Therefore, teaching materials are needed that can be used and support the implementation of online learning, so it is very necessary to develop teaching materials (modules) in electronic form. The results of the preliminary study and needs analysis showed that 61.5% needed module development in electronic form in the mathematics statistics course, and 23.1% in printed book form (Fig.1).

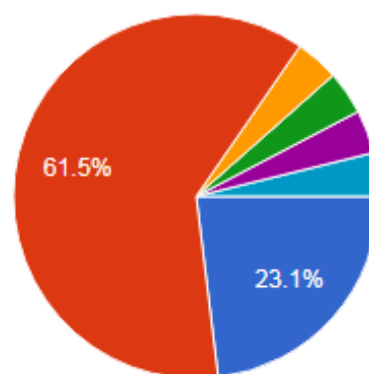


Figure 1. Percentage Analysis of E-module Development Needs

Many e-module development studies have been carried out including (Suarsana & Mahayukti, 2013; Widiani, 2022). The results of research by (Suarsana & Mahayukti, 2013) show that the development of e-modules in algebra courses can improve students' critical thinking skills. Meanwhile, the results of (Widiani, 2022) show that the development of math e-modules using the Kvisoft Flipbook Maker application can improve students' mathematical representation abilities and motivation in learning mathematics.

The results of the needs analysis and the studies that have been carried out show the need for the development of an e-module in the mathematics statistics course that is oriented towards schematic representation. This is in line with research by Mainali (2021) which shows that it is very important to implement representation in learning. The results of the studies that have been carried out have not shown a focus on the development of e-modules that are oriented towards one



type of mathematical representation and material content on mathematical statistics can improve students' mastery of schematic representations.

METHOD

This research method is Research and Development (R&D) which is intended to develop an e-module of mathematical statistics that is oriented towards schematic representation. The design for the development of the first mathematical statistics e-module in this study includes several stages that will be carried out according to Figure 2.

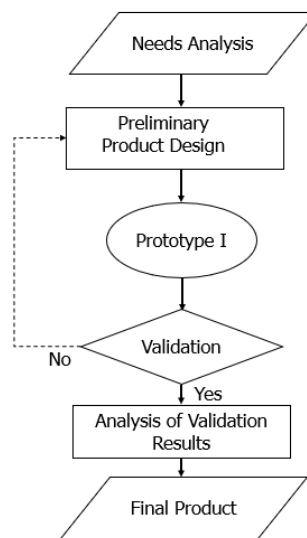


Figure 2. Stages of e-module development

The subjects of this research were all students in the fourth semester of the mathematics education course, totaling 25 students who studied mathematical statistics I. While the instruments used in this study were expert validation sheets, lecturer and student response questionnaires. Before using the instrument, the validation form is submitted to professors who are experts in statistics and experts in mathematics learning to obtain comments, suggestions and criticisms as a basis for improving the product. Lecturer and student response questionnaire sheets were given directly to two lecturers in the mathematics education study program and 25 students taking the mathematical statistics I course. This questionnaire is used to



determine the response of lecturers and students to the material, e-module design, and the problems presented which lead to the use of schematic representations in solving them. Data analysis techniques include quantitative and qualitative data analysis. Quantitative data analysis in this study was carried out on validity and practicality test data of e-module products. Validity analysis is done by counting the average evaluation of e-module products is based on the validators' assessments. The results obtained were then matched to the standards in Table 1.

Table 1. Product Validity Criteria

Percentage (%)	Validity Criteria
$80\% < \text{score} \leq 100\%$	Very Valid
$60\% < \text{score} \leq 80\%$	Valid
$40\% < \text{score} \leq 60\%$	Valid Enough
$20\% < \text{score} \leq 40\%$	Less Invalid
$0\% < \text{score} \leq 20\%$	Invalid

(Bintiningtiyas & Lutfi, 2016)

The practicality data analysis is assessed based on the average calculation of the e-module assessment by lecturers and students. The practicality calculation results obtained are then matched to the standards in Table 2.

Table 2. Product Practicality Criteria

Percentage (%)	Practicality Criteria
$80\% < \text{score} \leq 100\%$	Very Practical
$60\% < \text{score} \leq 80\%$	Practical
$40\% < \text{score} \leq 60\%$	Practical Enough
$20\% < \text{score} \leq 40\%$	Less Practical
$0\% < \text{score} \leq 20\%$	Impractical

(Bintiningtiyas & Lutfi, 2016)

RESULT AND DISCUSSION

The results of the development of the mathematical statistics e-module include several stage, namely: 1) Needs analysis; 2) Preliminary product design; 3) Prototype I; 4) Validation; 5) Analysis of validation results; 6) Final Product. The description of the development at each stage is presented as follows:



1) Needs Analysis

Based on the results of the preliminary study, it was shown that 62.5% (Fig. 1) of the respondents expected the development of a mathematical statistics module in electronic form. These results were obtained from respondents totaling 25 mathematics education students who filled out the questionnaire directly. Electronic modules in digital form are modules that can be accessed via devices without any time and place restrictions (Rahmadhani, 2016; Marlina et. al., 2022). In addition, electronic learning media can make the learning process more interesting, interactive, can be done anytime and anywhere and can improve the quality of learning (Prasetya et al., 2017; Yulando et al., 2019). Hence, developing an e-module was deemed highly suitable to facilitate student learning, given the advantages of electronic resources.

The results of the analysis of learning outcomes in the Mathematical Statistics I course hope that students can master the concepts of random variables and discrete probability distributions, the concepts of continuous probability distributions and empirical distributions, combined probability distributions, random variable means, variance and covariance, probability distributions of discrete random variables, random variables and distribution function and its properties, joint distribution of random variables and their properties.

2) Preliminary Product Design

The initial design stage of product development is to develop an e-module of mathematical statistics that is oriented towards a schematic representation in accordance with the needs analysis that has been carried out. The selection of material on the topics presented comes from several appropriate references. At the end of each topic, several problems are presented that train students in using schematic representations. Materials in the e-module include: 1) The concept of random variables and discrete probability distributions; 2) The concept of continuous probability distribution and empirical distribution; 3) The concept of joint probability distribution; 4) The concept of the mean of random variables; 5)



The concept of variance and covariance; 6) The concept of probability distribution of discrete random variables; 7) The concept of random variables and distribution functions and their properties; 8) The concept of joint distribution of random variables and their properties. In the initial design stage of this product, the selection of the writing format, the typeface used, and the selection of relevant questions and problems were also carried out. In addition to compiling the e-module, at this stage a validation instrument was also prepared that would be used to measure the level of validity of the e-module product.

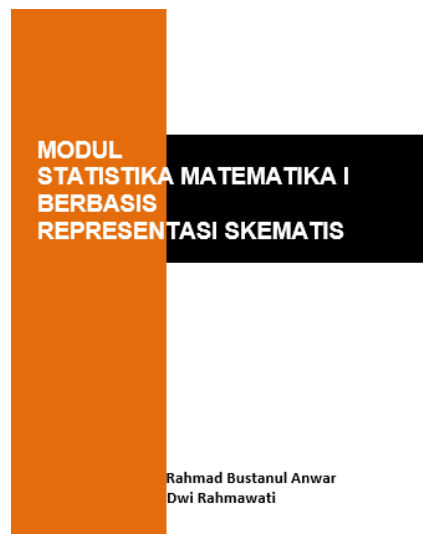


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DAFTAR ISI

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3) Prototype I

At this stage, the initial design (prototype I) was obtained in the form of a mathematical statistics e-module which is oriented towards schematic representation in accordance with the applicable curriculum and material. This prototype I becomes material for assessing validation which will be assessed by experts.

4) Validation

The validation stage is conducting research on the e-modules that have been produced. E-module validation involves experts in statistics and mathematics learning. To assess the validity of the e-module, experts carry out an assessment according to the instruments provided. The elements of the validation instrument include the coverage of mathematical statistics material, the relationship between questions and problems with schematic representations, the language used, and the presentation of the e-module design. The results of the expert validation (Fig. 5) show that the validator 1 in the field of statistics obtained a result of 85.7%. While the validator 2 in the field of learning mathematics obtained results of 90.4%. Based on the results of the expert validation test from two expert validators, it was concluded that the e-module of mathematical statistics category is very valid.

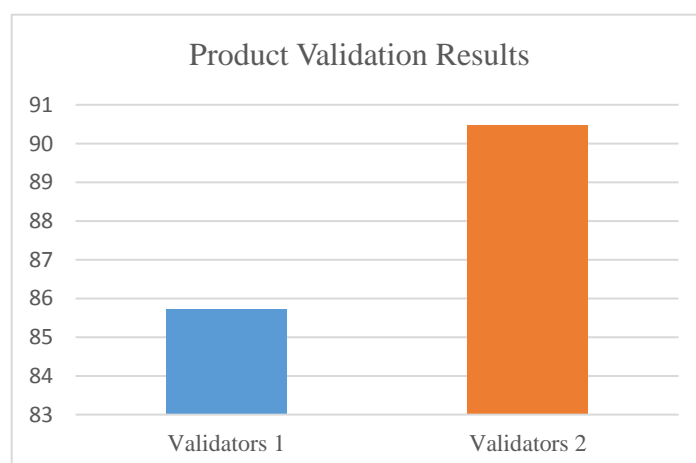


Figure 5. Product Validation Results



The results of the practicality test (Fig. 6) conducted by the lecturers obtained results of 85.7% in the very practical category. While the results of the practicality test from students obtained results of 76.1% in the practical category.

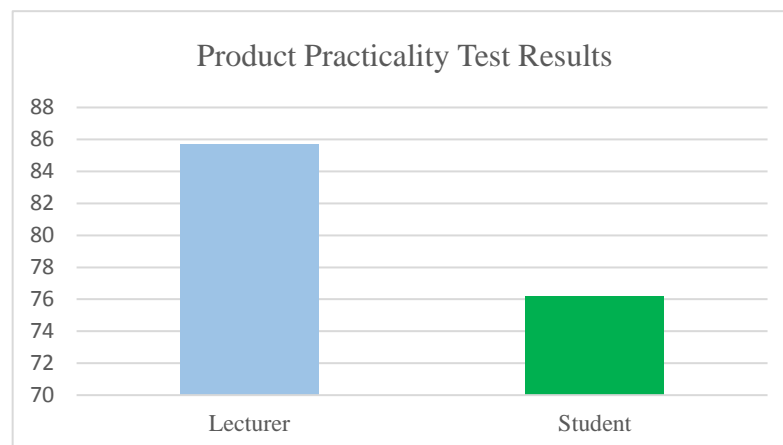


Figure 6. Product Practicality Test

5) Analysis of Validation Results

Based on the validation results that have been carried out on two experts, namely statistics and mathematics learning, the results obtained are 85.7% (validators 1) and 90.4% (validators 2). The results of the two validators show that the product of the e-module mathematical statistics category is very practical. In addition to providing an assessment in the form of a score, the validator also provides written corrections and suggestions. Corrections and written suggestions include the language used, and the editorial content of the problems presented. Besides that, based on the results of the practicality test from the lecturer, the results obtained were 85.7% in the very practical category. While the results of the practicality test from students obtained results of 76.1% in the practical category.

6) Final Product

Based on the process of developing the e-module mathematical statistics that has been implemented includes the following stages: 1) needs analysis, 2) initial product design, 3) Prototype I; 4) validation; and 5) analysis of the validation results obtained from the e-module of mathematical statistics which is oriented towards



schematic representation which is declared valid and practical and ready to be used in the lecture process.

CONCLUSION

The results showed that the product of the mathematical statistics e-module oriented to the schematic representation that had been developed was stated to be very valid based on the results of expert validation in the field of statistics and mathematics learning with an average of 88.05%. Validity was assessed by expert reviewers based on criteria such as content coverage, language, and design elements. In addition, the results of e-module development are also stated to be very practical based on research by lecturers and students of mathematics education with an average of 80.9%. Practicality was determined through lecturer and student evaluations that examined aspects like ease of use, interactivity, and facilitation of learning. Based on the research results, it can be concluded that the developed mathematical statistics e-module oriented towards schematic representation is very valid and practical for use. The e-module facilitates student learning by providing a valid and practical resource focused on schematic representations. The development of this e-module addresses a crucial need for learning resources that support students' schematic representation skills, which are vital for mathematical problem-solving.

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