International Journal of Research and Review
Vol. 10; Issue: 10; October 2023
Website: www.ijrrjournal.com
Research Paper *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Development of an Integrated Statistics E-Module with Flipbook and Augmented Reality

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DOI: https://doi.org/10.52403/ijrr.20231054

ABSTRACT

Numeration is an important aspect of learning mathematics. Numeration is the ability to apply mathematical symbols to solve everyday problems. The importance of numeration contradicts the conditions in the field, which show that students in the statistics class have not been able to solve problems related to numeracy properly due to a lack of multi-representational skills. This truth is evident from the opening observations made in statistics class revealed that, out of 37 pupils, only 12 were successful in converting verbal and graphic representations into symbolic ones to solve statistical issues correctly. In the meantime, 17 out of 25 students failed because they did not comprehend the issues represented graphically. The SPSS practice video barcode and software of studio.essemblrword.com has been used in statistical module development research to find a solution to this issue. All of these programs are integrated into e-modules, which are packaged in flipbook form. Define, design, develop, and disseminate steps of the 4-D model are used in the development process. In this study, a questionnaire was employed as a data gathering tool. Both qualitative and quantitative data were collected. The findings demonstrated that the produced module met the extremely feasible criteria for content feasibility (85.78%), linguistic feasibility (88.61%), presentation feasibility (84.82%), and visual feasibility (84.72%).

Keywords: Statistic E-Module, Multiple Representation, Augmented Reality

INTRODUCTION

A key objective of learning mathematics is to use mathematical thinking and numeration while addressing problems (1,2). An essential component of mathematical thinking is the capacity for using many representations to convey mathematical ideas (3, 4). This is due to the fact that one of the psychological words used in learning mathematics to describe significant thought occurrences is the concept of representation. As a result, whenever someone considers a mathematical scenario, they have already created a mathematical representation (5). Different representations are seen in presentation problems, parameter analysis, and statistical analysis in statistical material. They include visual representations like tables, graphs, and diagrams as well as vocal and written text representations of mathematical symbols. In order to translate the mathematical concepts included in the variety of mathematical symbols, students must be able to use the variety of representations (multiple-representation) (6, 7). To put it another way, students' multi-representational skills assist their statistical problem-solving skills.

The manifestation of abstract ideas or concepts in several formats or ways is known as multi-representation (3). In order to effectively facilitate learning in the classroom, lecturers must use multi-representational features, claim (4,8). The

incorporation of multi-representational elements in learning model construction by lecturers can boost the efficacy of the models. Students can also become more adept at using numbers and mathematical symbols to find solutions to real-world issues in a variety of situations.

The importance of the multi-representation aspect as mentioned above appears to be at odds with the reality, which demonstrates that many students still struggle with multi-representational abilities. Only 12 of the 37 students enrolled in the statistics course could correctly read the symbols in the SPSS analysis findings, according to the initial observation, which showed this. Only 8 out of the 12 students could successfully complete statistical puzzles. Additionally, it is noted in the report (9) that Indonesia is 71% and 60% below the minimal competency in terms of its capacity to apply different representations in the application of mathematical and scientific literacy, respectively. This demonstrates how a student's proficiency, particularly in problem-solving—in this instance, a statistical problem—is influenced by their capacity to use a variety of representations.

An innovative multi-representational statistical e-module will be created to help students improve their problem-solving abilities with statistical material in order to solve this issue. The innovation that manifested itself was the addition of ICT to existing e-module media for statistics learning (TPACK) (10-12). A video barcode on the practice of presenting and analyzing data using SPSS and software of studio.essemblrword.com are included in the e-statistics curriculum. All of these programs are integrated into e-modules, which are packaged in flipbook form. With this innovation, pupils are anticipated to be able to apply subject-matter expertise and technological know-how to resolve issues that call for multiple representations. In light of the background information provided above, the aim of this work is to create a cutting-edge multi-representation-based e-module that is appropriate for use in statistical learning.

MATERIALS & METHODS

The-define, design, develop, and disseminate steps of the Four-D model are used in the development process (13). In this study, a questionnaire was employed as a data gathering tool. The material experts for the e-statistics module are people with expertise in mathematics, particularly statistics (ADH), language experts with expertise in textbook publishing (EP), mathematics learning media experts with expertise in learning technology (AN), and 37 students from Statistics 3C class for a limited trial. This is because, small group trials were given to 20- to 30-student groups (14).

In this development, both qualitative and quantitative data were collected. In contrast to quantitative research, which collects data in the form of statistics, qualitative research is more descriptive and uses words or images to convey its findings (14,15). Quantitative data came from student response questionnaires that were analyzed using the percentage technique and validation results that were presented to experts in the form of a questionnaire validation sheet. Qualitative data came from a questionnaire that was reviewed by experts or validators. Furthermore, the validation sheet was analyzed by researchers using data processing formulas that referred to research (14). The interpretation criteria showed in Table 1.

$$V = \frac{\sum S}{[n(c-1)]}$$

Information:
V = validity
s = the lowest score in the validity assessment
c = the highest score in the validity assessment
n = number of validators or expert

The index criteria used in this study were taken from (8) namely:

TABLE 1. Interpretation of Feasibility Statistics E-Module

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

Three research tools, including a study sheet, a validation questionnaire sheet, and a student response questionnaire sheet, were employed in this study. The three experts received the review sheet and validation sheet. Both a quantitative and descriptive analysis was done on the three experts' validation questionnaire. The percentage is calculated using the Likert Scale scores (8) and a description of the rating scale for expert validation, where "5" denotes very good, "4" good, "3" fairly good, "2" not good, and "1" denotes extremely terrible value. The criteria for an effective emodule assessment, including self-instructional, self-contained, stand-alone, adaptable, user-friendly, and consistent (15, 16), were used to build the material review and validation sheets for the assessment items. Closed surveys pertaining to student responses underwent quantitative and descriptive analysis (8, 14). Based on the computation of the Guttman Scale, and a description of the rating scale for students' opinions, "Yes" has a value of one and "No" has a value of zero, the percentage is determined. The module is thought to be practicable or valid to utilize if the interpretation is 61%, according to the analysis of the student response questionnaire findings. The categories listed in Table 1 are used to categorize the outcomes of the evaluation of the three experts' and students' responses. If 61% of participants are eligible, the novel multi-representation-based statistical e-module is considered practical.

The final stage in the development of this statistics e-module is dissemination. Dissemination is the stage of spreading a product so that it is useful for society. Dissemination activities in this research were carried out through product adoption, namely statistics e-modules, by lecturers in the mathematics education study program at Nusantara University PGRI Kediri.

RESULT

A four-D development model (define, design, develop, and disseminate) is employed in this project. **Define stage**. The learning needs are defined and determined at the defining step. This stage consists of five steps: front-end analysis, learner analysis, task analysis, concept analysis, and development of statistical e-modules. The learner analysis seeks to examine student characteristics as an example for the design and development of statistical e-modules.

The results of the initial analysis of learner showed that 78% of students could not read descriptive statistics graphs correctly, and 82% of students could not draw conclusions correctly when solving statistical inferential problems in hypothesis testing material. The task analysis seeks to identify tasks in the statistics e-module teaching materials, and the concept analysis seeks to identify concepts in the statistical e-module teaching materials. By creating different representations, the learning target (or specific instructional objective) aims to improve students' ability to solve statistical problems.

Design stage. The goal of this design phase is to create a cutting-edge multi-representational statistical e-module. This design process consists of two steps: format selection (for the module format) and first design (for the module design). The front cover of the module is followed by the back cover in the module format. The module's content is organized into four sections: a summary of the presented information; material described from indicators; practice problems on descriptive statistics and inferential statistics; and statistical evaluation. Designing a module is a task that involves creating a physical model of a module to make it more engaging and encourage pupils to learn. Figure 1 depicts the module's original design.

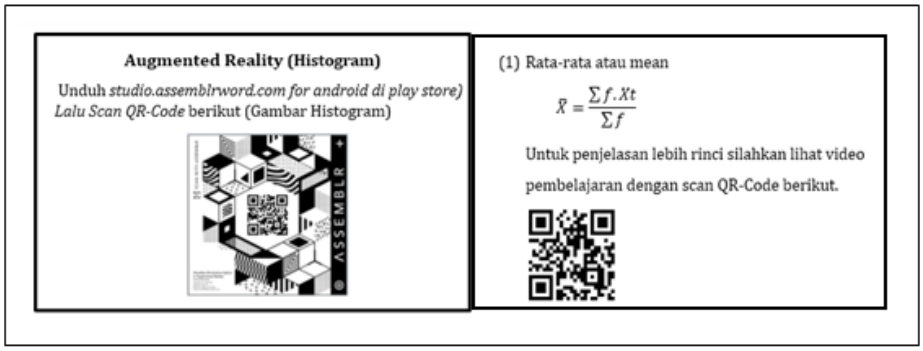

FIGURE 1. Initial Design

Development stage. The goal of the development phase is to create a workable revolutionary multi-representation-based statistical e-module. The development of a statistics e-module in this research uses a flipbook, which can be accessed by e-module users. In developing e-module content based on the content analysis stage that has been carried out, the e-module has been equipped with augmented reality assembler studio, learning video barcodes, as well as practical steps for the SPSS 21 program. The results of the e-module development before being validated are shown in Figure 2.

FIGURE 2. Prototype of Statistic E-Modul

The next step, this module's viability is evaluated using ideas from or confirmation by professionals, specifically material experts, linguists, and graphic experts. Students' replies to a questionnaire they completed after utilizing the e-module during a brief trial are used to determine the success of the module. The purpose of the e-module review is to gather suggestions for enhancing the generated module's content. The following changes were made to the module as a result of feedback from subject-matter and language experts: 1) the addition of video examples of questions from the normality and homogeneity tests; 2) the correction of minor spelling mistakes in the e-module; and 3). The following changes were made to the module as a result of feedback from graphic experts: 1) The cover's color is now more attractive while still maintaining the image's balance and the background; 2) The e-module format complies with ISO standards; and 3) Graphic images in each chapter need to be sharpened. The validation results of the experts can be used to determine whether the built module is feasible. A rating scale and ideas for improvement from each validator can be the validation's outcomes. The quantitative data from the validation results is what is utilized to assess the validity and viability of the e-module. According to the experts' validation analysis, which included the qualities of a good module assessment—self-instructional,

self-contained, standalone, adaptive, user-friendly, and consistent—the results are summarized 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

Based on Table 2, which shows that the average percentage of the feasibility of the teaching materials' content, presentation, language, and graphics is 86.084%, it can be said that the e-module's feasibility is classified as "very feasible" based on these factors. In addition, a small trial involving 37 students was carried out to determine how the students felt about the newly constructed e-statistics program. Students will be asked to complete a response questionnaire as part of the data collection process. Three criteria—suitability with statistical content, physical appearance, and language—are included in the student response survey. Implementation of response evaluation is planned for September, according to the research plan schedule.

Disseminate stage. The dissemination stage aims to disseminate research products to the public. In this research, the distribution of e-modules was carried out through adoption activities by lecturers in the Nusantara University PGRI Kediri mathematics study program. The lecturers signed a statement of activities to adopt the results of this research, which will be implemented in statistics lecture activities. Dissemination of e-module products is carried out by sharing the link and QR code of the Statistic e-module flipbook page.

DISCUSSION

Using quantitative descriptive analysis approaches, specifically by turning quantitative data into percentage form and then interpreting it with qualitative phrases, the data presented were assessed based on the findings of expert validation. With an average percentage of 85.78%, the content feasibility component falls into the highly feasible group. This is so that it can meet the criteria of being self-instructional, self-contained, stand-alone, adaptive, user friendly, and consistent (16-18). The e-module was developed to contain concepts and theories that are presented by CP and ATP, as well as learning indicators. With an average percentage of 82.45%, the presenting feasibility component falls under the highly feasible category. This is supported by the presentation of instructional materials that have all necessary components, such as systematic consistency of presentation, conceptual coherence, suitability of illustrations with material, presentation of texts, tables, pictures, and attachments accompanied by references/reference sources, motivational learning tool at the beginning of chapters, summaries, bibliography, and glossary(19, 20).

With an average of 88.61%, the language eligibility component is rated as extremely feasible. This is corroborated by the language used in the e-module, which makes reference to good and proper Indonesian grammatical conventions. This means that all teaching materials must pay attention to the linguistic component in accordance with the elements 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 the learning material (21).

The e-module layout's average percentage of the graphic feasibility component is 84.72%, which qualifies it as very viable. This is complemented by the appealing colors and drawings used in both the e-module cover design and its content to make the thoughts, messages, and ideas it conveys more-clear. The use of the e-statistics module by students can be encouraged by attractive graphics and an effective layout in instructional materials.

CONCLUSION

The conclusions of the creation of a statistic e-module based on multi-representation abilities are as follows, depending on the

phrasing of the problem taken: (1) this development results in a product in the form of an original multi-representation-based statistical e-module. 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; (2) this development was developed using a modified 4-D model that includes defining, design, and development steps; (3) student responses to innovative multi-representation-based statistical e-modules are positive with very feasible criteria.

Forward several recommendations, including: (1) it is hoped that educators will pay more attention to students' multi-representational skills in problem-solving as a result of the availability of this innovative multirepresentation-based statistical e-module; (2) it is suggested that product developers can then make products with other materials that incorporate augmented reality innovations; and (3) the following developer is expected to not only stop until the developing stage but can continue.

Declaration by Authors

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: Ika Santia, Darsono, Adelia Kusuma Wardani, Am Ayu Kusuma Dewi. Development of an integrated statistics E-Module with flipbook and augmented reality. *International Journal of Research and Review*. 2023; 10(10): 436-442.
DOI: *https://doi.org/10.52403/ijrr.20231054*

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