Development of Inferential Statistics Teaching Materials Using ADDIE Model

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Abstract. Statistics learning is one of the compulsory lessons learned at the Mathematics Education Department of Universitas Muhammadiyah Purwokerto for undergraduate students. This study aims to produce statistical teaching materials for mathematics education research, especially for Inferential Statistics that are suitable for use in lectures. The research method used is the method of research and development. The teaching materials development model used in this study uses steps adapted from ADDIE research and development model, which consists of five stages, namely Analysis, Design, Development, Implementation, Evaluation. The results of the evaluation were obtained from suggestions from lecturers and students during the trial, so that from this evaluation stage a final revision was carried out. Valid, the results of the validation of material experts with an average of 3.26 are in the very valid category, because $3 \leq M \leq 4$, so the material in the media is said to be very valid, while the results of the validation of media experts with an average of 3.18 are in the very valid category, because $3 \leq M \leq 4$, so this teaching materials is said to be very valid. Effective, this is said to be effective because the teaching materials is rated by students with an average percentage of positive responses of 83.27%. Practical, it is said to be practical because the percentage of teaching materials implementation is 80.43%.

Keywords: Inferential Statistics, Teaching Materials, ADDIE Model

1 Introduction

Research and Development is a process or steps to develop a new product or improve an existing product [1]. The purpose of this method is used to produce certain products in testing the effectiveness and usefulness of the product, and to find out how respondents respond to the products being developed [2]. The development model is the basis for developing the product to be produced. Development models can be in the form of procedural models, conceptual models, and theoretical models. The procedural model is a model that is descriptive in nature, showing the steps that must be followed to produce a product. The conceptual model is an analytical model that states the components of the product, analyzes the components in detail and shows the relationships between the components to be developed. Theoretical model is a model that describes a frame of mind based on relevant theories and is supported by empirical data [3].

There are many types of teaching materials available such as books, modules, and textbooks. Learning will run effectively and efficiently if it uses teaching materials that suit the needs of students, supports the competencies to be achieved by students, has a systematic

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description, standardized tests and appropriate learning strategies for students. Therefore, a lecturer must be able to prepare teaching materials and learning strategies that are suitable in every lesson in class [4].The teaching material from the handout only describes the subject matter without any training as independent learning. This is in accordance with the opinion of Komalasari (2010) that teaching materials circulating in the market are oriented towards formal learning materials and are taken from supporting disciplines, but do not pay attention to learning materials taken from the environment where students live so that the conceptual relationship learned by students through this teaching material, it is not related to the daily life of students [5].

Anwar stated that the characteristics of the learning module are as follows: (1) Self-instructional means that students are able to teach themselves, not depending on other parties; (2) Self-contained means breaking the learning material from a single unit of competence to be learned contained in one intact module; (3) Standalone means that the developed module does not depend on other media or does not have to be used together with other media; (4) Adaptive means that the module should have high adaptive power to the development of science and technology; and finally (5) User friendly, meaning that the module should also meet the rules of being comfortable with the wearer [6].

Learning to use modules has many benefits, students can be responsible for their own learning activities, learning with modules really appreciates individual differences, so that students can learn according to their level of ability, so learning will be more effective and efficient. Lasmiyati and Harta explain the advantages of learning with modules, namely (a) the module can provide feedback so that students know their shortcomings and immediately make improvements, (b) in the module set clear learning objectives so that student learning performance is directed in achieving learning goals, (c) modules that are designed to be attractive, easy to learn, and can answer needs will certainly lead to student motivation to learn, (d) modules are flexible because the module material can be studied by students in different ways and at different speeds, (e) cooperation can be established because with modules competition can be minimized and between learners and learners, and (f) remedies can be done because modules provide sufficient opportunities for students to be able to find their own weaknesses based on the evaluation given [7].

Munadi argues that media comes from Latin, namely medius which means middle, introduction, or intermediary. In the context of learning Susilana and Riyana defines teaching materials as anything that can convey and stream messages from sources in a planned manner so as to create a conducive learning environment where recipients can carry out the learning process efficiently and effectively [8]. More specifically, the notion of media in the learning process tends to be interpreted as graphic, photographic, or electronic tools to capture, process, and reconstruct visual or verbal information [9].

The use of appropriate instructional media is a strategic step to improve national education standards, especially standard processes, facilities and infrastructure. Discuss learning to accommodate the concept of teaching (teaching) and the concept of learning that is adjusted to the activities of students [10]. Therefore, in the learning system there are components of students, objectives, materials to achieve goals, procedures, and media that must be developed. Learning designed by facilitating independent learning students can train them to become lifelong independent learners, and in turn they become important components for realizing a learning society. Sadiman stated that the teaching materials of their procurement readiness are grouped into two, namely media that are already a trading commodity and are in a ready-to-use state, and media designs because they need to be specially designed and prepared for specific

learning purposes or objectives. (media by design). Module as one of the teaching materials has one principle, namely the principle of independent learning [11].

One of the subjects in Mathematics Education Department at Universitas Muhammadiyah Purokerto is Inferential Statistics course. Hearing the word Statistics is like a scourge that must be learned. In fact, the use of Statistics was known before the 18th century, at that time the state of Babylon, Rome, issued records of names, ages, sexes, occupations and number of family members. In Indonesia, the introduction of statistics has been included in the elementary school mathematics curriculum since 1975. This is because the environment around us is always related to statistics [4].

According to Lyman and Longnecker states that, Statistics is a branch of science that studies how to plan, collect, analyze, interpret and present data and draw conclusions based on data collections and analyzes carried out. Statistical methods are procedures used in collecting, presenting, analyzing and interpreting data. Meanwhile, Statistics serves only as a tool. The role of statistics in research remains as a tool. This means that statistics are not the goal that determines other components of research. Therefore, which plays a role in determining the problem that is sought answers from the research objectives itself. Statistics can be useful in designing models, formulating hypotheses, developing data collection tools, compiling research designs, determining samples, and analyzing data, which are then interpreted so that they are meaningful [12].

Inferential Statistics has the aim of drawing conclusions. Before drawing conclusions, an assumption is made obtained from descriptive statistics. Examples of Inference Statistics problems include: (a) Statistical Estimation, (b) Hypothesis Testing (c) Forecasting by Regression. Somantri and Muhidin state that Inference Statistics discusses how to analyze data and make decisions (related to parameter estimation and hypothesis testing [13]. Meanwhile, according to Sudijono, Inference Statistics are statistics that provide rules or methods that can be used. used as a tool in order to try to draw general conclusions, from a set of data that has been compiled and processed [14].

2 Method

The type of research used in this research is research and development, starting from data collection, interpretation data, and interpretation research results. Location of this research was conducted at Universitas Muhammadiyah Purwokerto. Sample used in the study was 30 students that take inferential statistics courses.

2.1 ADDIE Model Procedure

The development model is defined as a conceptual design process in an effort to increase the function of existing models, through the addition of learning components that are considered to improve the quality of achieving goals [15]. Based on product development steps, the ADDIE research and development model is more rational and more complete than the 4D (Define, Design, Development, and Disseminate) model from Thiagarajan. This model can be used for various forms of product development such as models, learning strategies, learning methods, media, and teaching materials [16].

2.1.1 Analysis

The main activity at this stage is to analyze the need to develop new learning models and to analyze the feasibility and requirements for developing new learning models. The development of a new learning model begins with a problem in the learning model that has been applied. Problems can occur because the existing learning model is no longer relevant to the need for advice, learning environment, technology, student characteristics and so on.

2.1.2 Design

The design of the learning model at the design stage is similar to designing teaching and learning activities. This activity is a systematic process that starts from setting learning objectives, designing scenarios or teaching and learning activities, designing learning tools, designing learning materials and learning outcome evaluation tools. The design of this learning model is still conceptual and will underlie the subsequent development process.

2.1.3 Development

Development in the ADDIE model contains activities for the realization of product designs. The activity at the design stage is to compile a conceptual framework for the application of a new learning model. Activities at the development stage are conceptual frameworks that are realized into products that are ready to be implemented. For example, if at the design stage a new conceptual model has been designed.

2.1.4 Implementation

The activity at this stage is to implement the designs and methods that have been developed in real situations, namely in class. During implementation, the design model that has been developed is applied to the actual conditions. The material is delivered according to the new model being developed. After applying the method, an initial evaluation is then carried out to provide feedback on the implementation of the next model.

2.1.5 Evaluation

Evaluation is carried out in two forms, namely formative and summative evaluation. Formative evaluation is carried out at the end of each face-to-face (weekly), while summative evaluation is carried out after the activity ends as a whole (semester). Summative evaluation measures the final competence of the subject or learning objectives to be achieved. The results of the evaluation are used to provide feedback to the model users. Revisions are made in accordance with the results of the evaluation or the needs that have not been met by the new model.

2.2 Product Trial Design

Product trials are intended to achieve valid criteria for blended-based learning products. The testing phase is carried out as follows:

2.2.1 Alpha Trial

For alpha testing, it is carried out by material experts and media experts, it can also be done by observers and parties who have the competence to evaluate the products being made. The results of the evaluations that have been carried out as the basis for making the first revision.

2.2.2 Beta Trial

For beta testing, it is carried out on a large scale by observers and students. The test results are used to make the final revision as a medium that is ready to be applied in a wide environment.

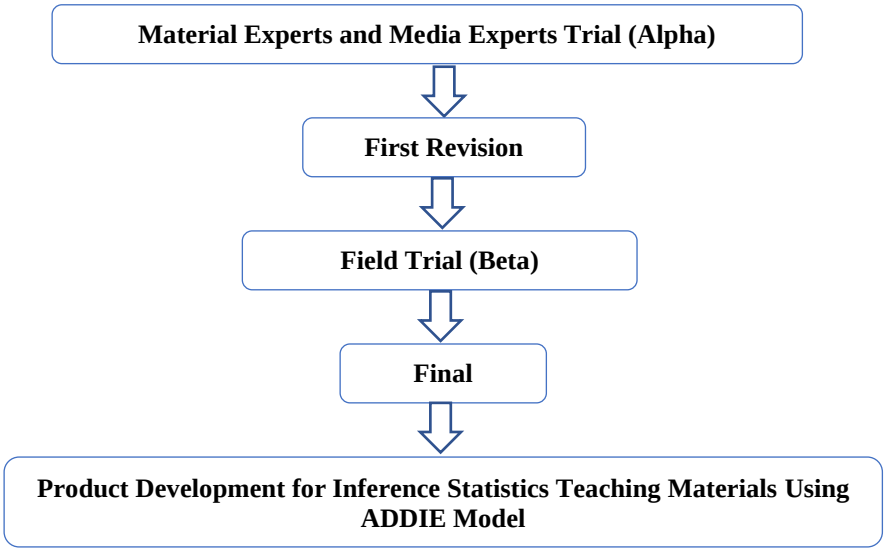

Fig 1. Trial Design

2.3 Research Instruments

The researcher prepared several instruments based on the guidelines that had been designed to obtain the necessary data. The instruments in question are material validation sheets, media validation sheets, student activity observation sheets, student response sheets, observer response sheets, and student learning outcomes tests.

2.3.1 Learning Material Validation Sheet

This instrument is used to obtain information about the validity of learning materials based on expert and practitioner assessments. The information obtained through this instrument can be used as material for consideration in revising learning materials oriented to the ADDIE development model developed so that it is suitable for use. On the learning material validation sheet, the two validators provide several assessments of several indicators including: content feasibility, and presentation feasibility. Each indicator has an instrument. The two validators are asked to write the appropriate score by giving a check mark on the appropriate row and column, that is, the validator is given a choice in the assessment column as very good, good, sufficient, lacking and very poor. The validator is then asked to provide a general assessment conclusion with the categories that can be applied without revision, can be applied with minor revisions and cannot be applied

2.3.2 Teaching materials Validation Sheet

This instrument is used to obtain information about the validity of teaching materials based on expert and practitioner assessments. The information obtained through this instrument can be used as material for consideration in revising the ADDIE development model-oriented teaching materials that was developed so that it is suitable for use. On the teaching materials

validation sheet, the two validators provide several assessments of several indicators including: optimization of learning objectives, media effectiveness, availability of media used, quality of media techniques and student characteristics. Each indicator has an instrument. The two validators are asked to write the appropriate score by giving a check mark on the appropriate row and column, that is, the validator is given a choice in the assessment column as very good, good, sufficient, lacking and very lacking. The validator is then asked to provide a general assessment conclusion with the categories that can be applied without revision, can be applied with minor revisions and cannot be applied.

2.3.3 Student Response Questionnaire

Student responses to modules can be found through a questionnaire. Student response questionnaires are compiled to collect one of the supporting data for the effectiveness of using teaching materials on the subject of building space with the ADDIE development model. The questionnaire was distributed to students after the last meeting to be filled in according to the instructions given. Student responses include student opinions on the learning process using teaching materials on the subject of building space with the ADDIE development model and the ease of understanding problems. The results of this questionnaire can be used as material for consideration to improve teaching materials and other supporting devices.

2.3.4 Observer Response Questionnaire

The observer response questionnaire was used to obtain supporting data on the effectiveness of using teaching materials on the subject of building space with the ADDIE development model. The questionnaire was distributed to the model observer after the last meeting was completed to be filled in according to the instructions given. The results of this questionnaire can be used as material for consideration to improve teaching materials and other supporting devices. This data can help in obtaining data on which aspects of the teaching material components and other supporting devices that need to be revised.

2.4 Data Analysis Techniques

2.4.1 Validity Data Analysis

The activities carried out in the process of analyzing the validity of the device data quoted from [17] are as follows:

1) Recapitulate the results of the expert's assessment into the table: Aspects (A_i), Criteria (C_i), and the results of the assessment (V_{ij})
2) Finding the mean of the assessment results from all validators for each criterion using the formula

$$\bar{C}_i = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}\bar{V}_{ij}}{n} \quad (1)$$

Where:

$\bar{C}_i$ = average of the i-th criteria

V_{ij} = the score of the results of the assessment against the i criteria by the j assessor

n = number of evaluators

3) Finding the average aspect using the formula

$$\bar{A}_i = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}\bar{C}_{ij}}{n} \quad (2)$$

Where

$\bar{A}_i$ = average i-th aspect

$\bar{C}_{ij}$ = average for the i-th aspect by the j-criterion

n = number of criteria in the ith aspect

4) Finding the average of the total using the formula

$$\bar{X} = \frac{\sum_{i=1}^{n}\bar{A}_i}{n} \quad (2)$$

Where

$\bar{X}$ = total average

$\bar{A}_i$ = average for the ith aspect

n = many aspects

5) Determine the validity of each criterion or the average aspect or total average based on the validity category

$3.5 \leq M \leq 4 \rightarrow$ Very valid

$2.5 \leq M < 3.5 \rightarrow$ Valid

$1.5 \leq M < 2.5 \rightarrow$ Not valid

$M < 1.5 \rightarrow$ Invalid

Information:

$M = \bar{K}_i$ to find the validity of each criterion

$M = \bar{A}_i$ to look for validiats every aspect

$M = \bar{X}$ to find the validity of all aspects

The criteria used to state that teaching materials and learning devices have an adequate degree of validity is the average value of validity for all minimum aspects in the fairly valid category and the validity value for each minimal aspect is in the valid category. If it does not meet these criteria, it is necessary to revise it based on the advice of the experts or by looking back at the aspects whose score is insufficient. Then re-validated and then analyzed again.

2.4.2 Analysis of Student and Observer Response Data

Student and observer response data were obtained from student and observer response questionnaires to learning activities, and then analyzed using descriptive statistics in the form of percentages. Activities undertaken to analyze student response data are as follows:

1) Counting the number of students who gave positive responses according to the aspect being asked, then calculating the percentage using the formula:$percentage\ of\ response = \frac{number\ of\ positive\ responses}{total\ number\ of\ respondents}$
2) Determine categories for positive responses from students and observers by matching the percentage results with the specified criteria. The response criteria for students and observers (RS) were adapted from Nurdin Asyad (2016) with the following conditions:
   $0.5 < RS \rightarrow$ Not very positive
   $0.5 \leq RS < 1.5 \rightarrow$ Not positive
   $1.5 \leq RS < 2.5 \rightarrow$ Quite positive
   $2.5 \leq RS < 3.5 \rightarrow$ Positive
   $3{,}5 \leq RS \rightarrow$ Very positive
3) If the results show that the student's response has not been positive, then a revision is made to what is being developed. The criteria established to say that students have a positive response is that more than 50% of students give a positive response to at least 70% of the number of aspects asked. Students' positive responses to the use of teaching materials are said to be achieved if the positive response criteria of students are met.

3 Result and Discussion

This study aims to develop learning-based media Geogebra in cone section material. The research and development procedure this is an adaptation of the ADDIE research and development steps developed by Dick and Carry in designing learning systems, which consists of five stages, namely Analysis, Design, Development, Implementation, Evaluation.

3.1 Analysis

The first stage in this research and development is the needs analysis stage by observing students taking Inferential Statistics courses. The results of this analysis will become a reference in the development of SPSS-based interactive teaching materials. The results of observations made by researchers are still minimal in the use of instructional media. Therefore, researchers think of developing new and more interactive teaching materials and attracting student interest and curiosity about teaching learning materials.

3.2 Design

The Second stage is a follow-up to the analysis stage. In the process of design teaching materials, a design sketch is needed to help make teaching materials. The first thing to do is formulate SMAR learning objectives (Specific, Measurable, Applicable, and Realistic). Furthermore, compiling a test, where the test must be based on the learning objectives that have been formulated. Then determine the appropriate media learning strategy to achieve the goal.

In addition, other supporting sources are also limited, such as relevant learning resources, what kind of learning environment should be. All of this is contained in a single document called a clear and detailed blueprint. Design is the second step of the ADDIE learning system design model.

3.3 Development

In this development stage, there are several things that are done, including:

3.3.1 Making Teaching materials

Media that have been designed by researchers and produce prototypes which are then created and developed. This media was developed using the SPSS application. The content of this teaching materials consists of materials obtained from various related sources.

3.3.2 Product Eligibility Validation

After the teaching materials has been made, validation of the feasibility of the product is carried out. Validation of teaching materials is carried out by expert validators and theoretical and practical considerations. Expert validators consist of media expert validators and material experts.

3.3.2.1 Material Expert Validation

There are 2 material experts in the teaching materials validation process using SPSS software. The material validation is related to the material releasing aspects. Validation by eligibility service material experts, material experts also provide comments and suggestions for improving the media. The results of the validation carried out by material experts can be obtained from the material relevance aspect obtained by an average of 3.26 which is included in the valid category.

3.3.2.2 Validation of Media Experts

There are 2 media experts in the validation of teaching materials using SPSS software. Validation by media experts is related to the appearance of the media. Validation by eligibility service material experts, media experts also provide comments and suggestions for improving the media. The results of the validation carried out by material experts can be obtained from that the media aspect is obtained by an average of 3.18 which is included in the valid category. So that in total, teaching materials using SPSS software that has been developed by researchers can be tested.

3.4 Implementation

This stage is a continuation of the Development stage. At this stage, all media designs that have been developed are applied after revision. Teaching materials using SPSS software that has been developed, implemented in real situations in class. However, at this stage, researchers only conducted product trials on small groups (limited trials) by looking at the responses from the lecturers and the responses from students to the teaching materials that had been developed.

Trial that corrects to see the level of practicality in the media. This limited trial consists of 1 lecturer and 30 students. Before conducting the trial, students were given instructions on teaching materials using SPSS. At the time of the limited test implementation, the researcher explained what was contained in the teaching materials. This is done by researchers so that students are more enthusiastic when learning material on the teaching materials.

After the lecturers and students finished paying attention to the teaching materials, then on the last day of the trial, a questionnaire was given by the researcher. This questionnaire aims to see the extent to which lecturers and students respond to teaching materials using the SPSS software that has been developed. The results of the responses of lecturers and students to teaching materials using SPSS software show that teaching materials using SPSS software in terms of lecturer responses has an average of 4.14, while the results of data analysis of student responses to the implementation of learning were followed by 30 students at the limited trial stage. with the average percentage of student responses to the implementation of learning activities using SPSS software has a value greater than 80%. From all aspects that were asked, the average percentage of student responses was 83.27%.

Thus, the high percentage of students who gave positive responses proved that SPSS-based interactive teaching materials could be said to be effective. In addition, a questionnaire was also provided in the form of the implementation of SPSS-based interactive teaching materials which was filled in by subject lecturers, with the results as in the following table: Based on the table above, the results of the implementation of SPSS-based interactive teaching materials were obtained with an average of 80.43%, which is above 80%. the implementation of interactive teaching materials can be concluded practical to use.

3.5 Evaluation

Evaluation is the last stage of the ADDIE development model. Because in this study only limited trials, the evaluation referred to here is an evaluation of implementation activities. The results of the evaluation were obtained from suggestions from lecturers and students during the trial, so that from this evaluation stage a final revision was carried out.

4 Conclusion

The process of developing SPSS-based teaching materials using the ADDIE development model is carried out in 5 stages, starting from the Analysis, Design, Development, Implementation, to Evaluation stages. At the evaluation stage, there are 3 criteria for whether the material is feasible or not before it is used, namely valid, effective, and practical. Valid, the results of the validation of material experts with an average of 3.26 are in the very valid category, because $3 \leq M \leq 4$, so the material in the media is said to be very valid, while the results of the validation of media experts with an average of 3.18 are in the very valid category, because $3 \leq M \leq 4$, so this teaching materials is said to be very valid. Effective, this is said to be effective because the teaching materials is rated by students with an average percentage of positive responses of 83.27%. Practical, it is said to be practical because the percentage of teaching materials implementation is 80.43%.

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