

Desenvolvendo Materiais Instrucionais de Matemática
Developing Mathematics Instructional Materials
Desarrollo de materiales didácticos de matemáticas

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Zulyadaini

ORCID: <https://orcid.org/0000-0001-5903-4641>

Batanghari University, Indonesia

E-mail: zulyad825@gmail.com

Resumo

Este estudo teve como objetivo desenvolver material didático de matemática na faculdade de ciências da educação da Universidade Batanghari, Jambi. Esta pesquisa utilizou o modelo de desenvolvimento instrucional. Em seguida, vários testes também foram realizados, como um a um aluno; grupo pequeno e teste de campo. Posteriormente, os sujeitos da pesquisa estão envolvendo os alunos do 6º semestre no período de 2017/2018. Os resultados então apresentados na porcentagem de validação que incluíam a validação do projeto totalizaram 92,71%; a validação de média foi de 89,78% e a validação de material foi de 92,5%. Além disso, o resultado da avaliação de um para um foi de 97,2%, o pequeno grupo de 93% e o de campo 88,63%. Assim, a partir da validação e avaliação conduzidas, então o material didático de matemática era digno de ser aplicado.

Palavras-chave: materiais de instrução; modelo de desenvolvimento instrucional; média instrucional de matemática.

Abstract

This study was aimed to develop mathematics instructional material in education science faculty of Batanghari University, Jambi. This research used Instructional Developmental Model. Then, several tests were also conducted such as one to one learner; small group and field trial. Afterwards, the research subjects are involving the 6th semester students along 2017/2018 period. The results then presented in validation percentage which were including design validation amounted 92,71%; media validation amounted 89,78% and material validation amounted 92,5%. Moreover, the result of one to one assessment was 97,2%, small

group 93% and field trial 88,63%. Thus, from the validation and assessment conducted, then mathematics instructional material was worthy to be applied.

Keywords: instructional materials; instructional developmental model; mathematics instructional media.

Resumen

El objetivo de este estudio fue desarrollar material didáctico de matemáticas en la facultad de ciencias de la educación de la Universidad de Batanghari, Jambi. Esta investigación utilizó el modelo de desarrollo instruccional. Luego, también se realizaron varias pruebas, como la de uno a uno; Grupo pequeño y prueba de campo. Luego, los temas de investigación involucran a los estudiantes del sexto semestre a lo largo del período 2017/2018. Los resultados presentados en porcentaje de validación, que incluían la validación del diseño, ascendieron a 92,71%; la validación de medios ascendió a 89,78% y la validación de materiales ascendió a 92,5%. Además, el resultado de la evaluación individual fue de 97,2%, grupo pequeño de 93% y prueba de campo 88,63%. Por lo tanto, a partir de la validación y evaluación realizadas, entonces el material de instrucción de matemáticas fue digno de ser aplicado.

Palabras clave: materiales didácticos; modelo de desarrollo instruccional; medios didácticos matemáticos.

1. Introduction

Teaching materials will be successfully delivered to the students if the teachers or lecturers use appropriate learning materials. The role of learning media is very important for deliver learning materials, hence, it can be easily comprehended based on the media used. According to Gagne as quoted in Sadiman (2014) medium or media is any kind of components in students' environment that can stimulate them to learn. It obviously describes that media can stimulate and motivate students in learning.

However, teaching materials that frequently practiced are general. Lecturers use general book and references in mathematics teaching materials, so that it still does not specifically address significant and pure mathematics. As a result, the students are difficult to create and develop mathematics learning materials that suit them the most. Meanwhile, a good teaching material can stimulate students to improve mathematics learning media. Therefore, it requires creativity in the class of mathematics learning material.

A study conducted by Wahyuni (2016) entitled "Development of Teaching Materials Based on Contextual Learning Regarding with Character Education in Accounting

Manufacturing Company Subjects of SMK Negeri 1 Turen” produced a learning material that has very decent predicate. It has 88,16% average value validation score from expert. Moreover, a study conducted by Zulyadaini (2017) entitled “A Development of Students’ Worksheet Based on Contextual Teaching and Learning” obtained a developed teaching material that has decent criterion by some experts. It has 79,06% average value of validation score and 88,6% average value of student’s response. Furthermore, a study conducted by Handayani (2011) entitles “Development of Accounting Learning Materials for Vocational Schools Based on Contextual and Cooperative Learning” is obtained a developed teaching material that decently applied. It has 78,7% validation average value from experts and 82% value from student’s response. Thus, based on the explanation above, it requires to design and develop teaching and learning materials in FKIP (Faculty of Teacher Training and Education) Batanghari University, Jambi.

2. Literature Review

2.1 Instructional Development Model

Instructional Development Model has characteristics that each step of instructional development model has practice objective not a theoretic. The instructional development model in this study analyzes the needs to identify learning problems and find the solutions. The structure of development model is illustrated in Figure 1.

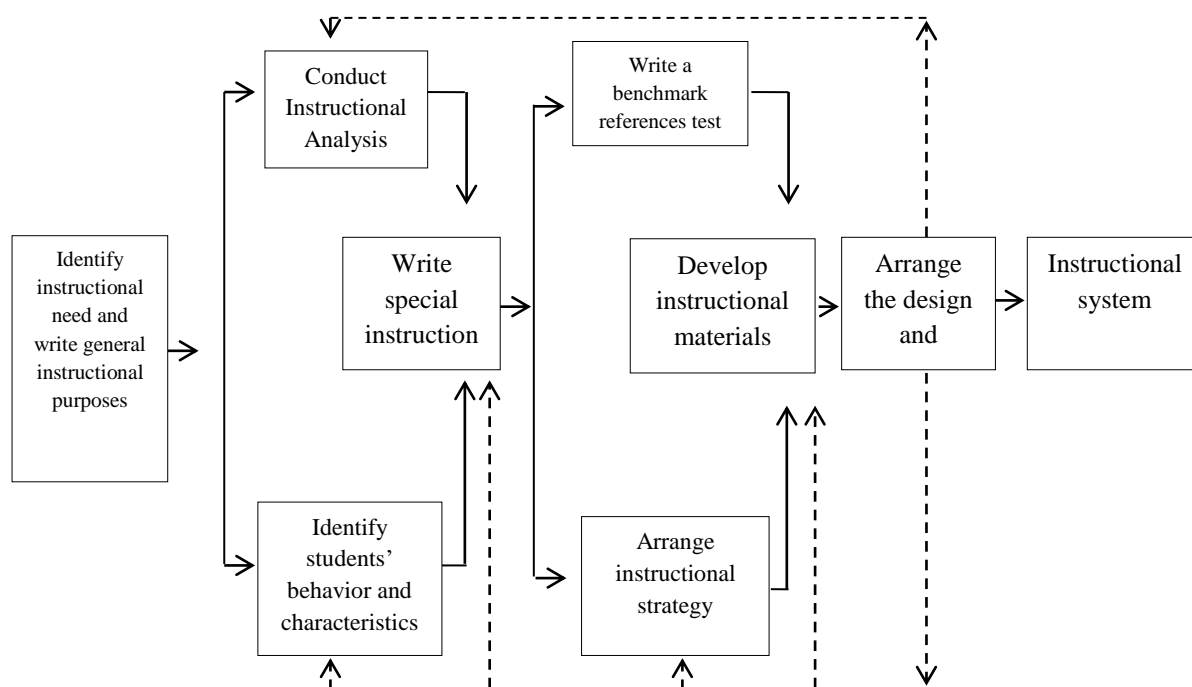


Figure 1. Instructional Development Model (Suparman, 2004)

Based on figure 1, the steps of Instructional development model as follows:

- a) Identify instructional needs and formulize general instructional objectives. This step is the initial step in identifying instructional process done in higher education. Data collection in this step used deep interview, field observation, and documentation. Based on the data analysis, the developmental form and instructional objectives can be formulized.
- b) Conducting Instructional analysis. This step is an explanation of general behavior to special behavior that logically and systematically organized. The analysis is done to classify materials that will be learnt.
- c) Identifying initial behavior and initial characteristics. This step is done to understand the students' behavior before the development in order to compare students' behavior after and before the development.
- d) Note Specific Instructional Objectives by discussing objectives and aims determined. The formulation of instructional objectives is a base of test writing and instructional strategy.
- e) Writing guide test for standard. Writing standard guides aims to examine students' skill maximally to achieve the target. Test writing that can be used as a tool to measure the level of students' achievement in achieving instructional objectives.
- f) Arranging instructional strategy. In this stage, students will develop strategy used in instruction. From arranging introduction process, core activity, closing, media, timing and measurement tools.
- g) Developing Instructional materials. Developing instructional materials is to develop materials in the form of material collection that are suitable with objective determined in the form of printed hand out.
- h) Designing and conducting formative evaluation. In this stage, students are writing measurement instruments and conducting formative evaluation towards instructional materials developed. Furthermore, the factor that is being evaluated is the strategy of instructional activity in mathematic.
- i) Obtaining the desired instructional system.

The result from this stage is a product in printed book. It is completed with other instrument required. Instructional development model is a simple model and understandable because all the steps are clear and enable to be revised any time (Suparman, 2012). However, a model may not be suit for several person, yet it suit for another person. Since, it is related to the certain condition and situation.

2.2. Relevance of Instructional Development Model

Instructional Development Model (IDM) is used as model for developing design system in mathematic learning. IDM have clear, simple, and understandable steps. In addition, it also has output or product since the steps are involving formative evaluation.

2.3. Teaching Materials

Sukiyasa (2006) postulated that learning process which is happened in the class, is determined by some teaching components such as: learning objectives, teaching materials, media and method, students (participants), and teacher. It was previously described in Depdiknas (National Department of Education) (2006) that teaching material is one of the important learning component to help students in achieving basic and standard competence. Moreover, according to Lestari (2013) teaching material is a target or teaching tools that contains learning materials, method, boundaries and evaluation method designed systematically and interesting in order to achieve the expected objectives. Then, the expected objective has aimed to achieve competence or sub-competence within its complexities. Teaching materials is any form of materials used to help teacher/instructor in executing teaching and learning activities in class. The material can be in the form of written material or un-written material (Majid, 2007). Meanwhile, Hamdani (2011) states that teaching materials or instructional materials mainly consists of knowledge, skill and attitude that must be learnt by students in order to achieve competence objectives determined. Thus, teaching materials can be applied for helping teachers in class which is aimed to achieve some competences.

2.4. Instructional Media

According to Asyhar (2012), etymologically, media was derived from Latin “media”, it was a plural form of “medium” which means “middle, mediator, conveyer”. The terms of message mediator or message conveyer from the sender to message’s receiver. Further, according to Gerlach and Ely in Arsyad (2015) stated that if media is understood mainly means human, materials or incidents that build conditions of students. It enables students to obtain knowledge, skill and attitude or behavior. Briggsqtd. in Sadiman (2014) argued that media is any physical tools that can present message and stimulate students to learn.

Thus, based on some previous definitions above, it can be concluded that instructional media is anything that can enhance motivation, stimulation, and enables students in understanding material conveyed especially understanding mathematics through mathematics instructional media.

3. Method

This study used Research and Development method which is used to examine effectiveness and produce particular product. To obtain the particular product, it is required to

conduct an examination or assessment to examine its effectiveness. From the examination results, it can be known whether the resulted product can be used by other people or not.

The subject in this study is involving students and teachers in even semester of 2017/2018 in Mathematics department of Teacher and Educational science, Batanghari University, Jambi. The material development is conducted in some steps as follow: 1) preliminary study, 2) developmental planning, 3) validation, evaluation and revision, 4) Implementation. The validation and formative evaluation are required to see the validity of teaching materials.

For the validation and formative evaluation are performed by some experts such as (1) one to one experts that is material experts, instructional design experts and multimedia experts, (2) one to one learner that is personally examination that is conducted to user subject or students as the user of the product. The sample consists of three students that have low, medium and high skill, (3) small group that is the examination to small group regarding on the instructional principles suitability with usage principles. The examination is conducted to 9 male students. They are divided to three groups based on their skill category. The skill categories were low, medium and high skill, (4) field trial that is the examination that is conducted in the field. It was conducted to 20 students.

4. Results

4.1 Analysis of Necessity and Formulation of Objectives

In the analysis stage, questioners were used, the interview was conducted to obtain the data regarding on the problems faced by lecturers and students. Based on the questioners' results, it shown that students have difficulty in understanding and creating instructional media that is suitable for mathematics since not a whole media is suitable for mathematics materials. Further, the interview results with lecturers shown that the materials, nowadays, are still using general references of instructional media. In other words, the specific instructional media for every major is still not founded. Thus, the specific references for mathematics instructional are still not found.

The goal of instructional development materials can be achieved if after the subjects of mathematics instructional media, students can create and use mathematics instructional media and use it to teach mathematics.

4.2 Instructional Analysis

Instructional analysis is a process of explaining general behavior to specific behavior that logically and mathematically arranged. The results of instructional analysis were: a)

describe mathematics instructional media's concept; b) explain the properties based on concepts of area (area, binomial multiplication, area of surface, game with area's concept), c) explain properties based on concept of length (ruler, the number line, balance sheet and Cuisenaire stem); d) explain the properties based on Volume (Cubes, beams, prisms, tubes, cones, pyres and balls Volume); e) Explain the Properties Based on Measurement Concepts (Wheel meter, sperometer, penjpit ball, calipers, determining bilan phi, trigometric function angle values, clinometer); f), Explain the Props Based on Arithmetic Concepts (calculating tools, number patterns, number operations, number operations, FPB and KPK); g) Explaining Based Teaching Tools Geometry Concept (flat building, tiling, nailing board, flat mirror); h), explain Possible Theory-Based Teaching Aids; i) Explain Game-Based Teaching Aids (Dominoes, bunjur cages and magic stars, jumping frogs, tower of hanoi); j), Explain Teaching Aids Based on Information and Communication Technology (ICT uses E-Learning, Audio Visual, analysis Toolpak).

a. Identifying preliminary behavior and characteristics.

The targeted objects were students who attended subjects of mathematics instructional media. They were university students of Batanghari University (UNBARI) on 7th semester in 2017/2018 academic year. Students that applied the mathematics instructional media were from different highschool beckground. They had motivations and high will and pleasure to learn.

4.4. Formulating specific instructional objectives

From the general objectives above, then the specific instructional objectives were as follows: a). Students can describe concepts of mathematics instructional media, b) students can the properties based on concepts of area (area, binomial multiplication, area of surface, game with area's concept), c). Explain properties based on concept of length (ruler, the number line, balance sheet and Cuisenaire stem), d) explain the properties based on Volume (Cubes, beams, prisms, tubes, cones, pyres and balls Volume), e) Explain the Properties Based on Measurement Concepts (Wheel meter, sperometer, penjpit ball, calipers, determining bilan phi, trigometric function angle values, clinometer), f), Explain the Props Based on Arithmetic Concepts (calculating tools, number patterns, number operations, number operations, FPB and KPK), g) Explaining Based Teaching Tools Geometry Concept (flat building, tiling, nailing board, flat mirror), h), explain Possible Theory-Based Teaching Aids, i) Explain Game-Based Teaching Aids (Dominoes, bunjur cages and magic stars,

jumping frogs, tower of hanoi), j), Explain Teaching Aids Based on Information and Communication Technology (ICT uses E-Learning, Audio Visual, analysis Toolpak).

4.5. Research Instruments

The research instruments in this study were score of middle test, final test, participation and competence test.

4.6. Formulating Instructional Strategy

The formulation of mathematics instructional strategy consists of three main activities they are introduction, main and closing activities. Moreover, in the delivery using varies method with period, media and properties required.

4.7. Developing Instructional Materials

The preparation of teaching materials is currently need the appropriate materials using appointed purposes. The teaching materials which have been prepared and developed based on IDM model. So therefore, it is needed to see the validity of materials. The result of validity which consists of validation and formative evaluation are:

a. One to one expert

1) Instructional design Expert

Validation results from instructional design experts based on the indicators illustrated in figure 2:

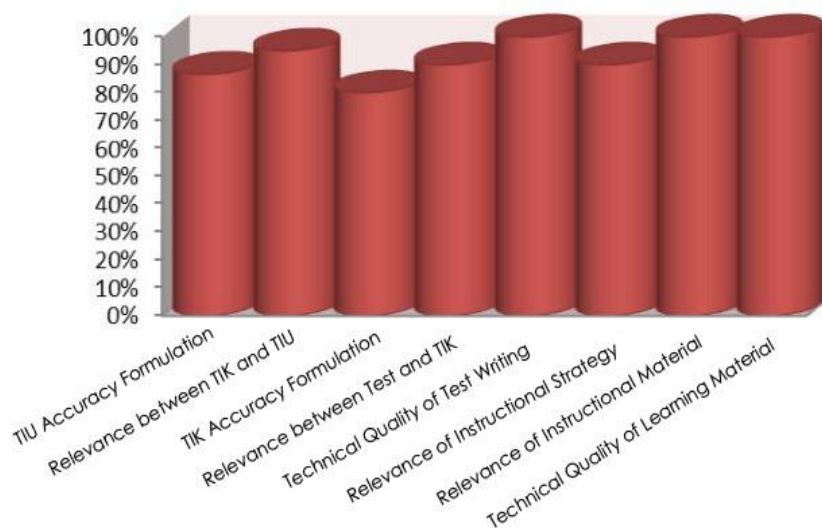


Figure 2. Validation result from Instructional Design expert.

2) Material Experts

Validation result from material experts based on the indicator of instructional material is illustrated in Figure 3.

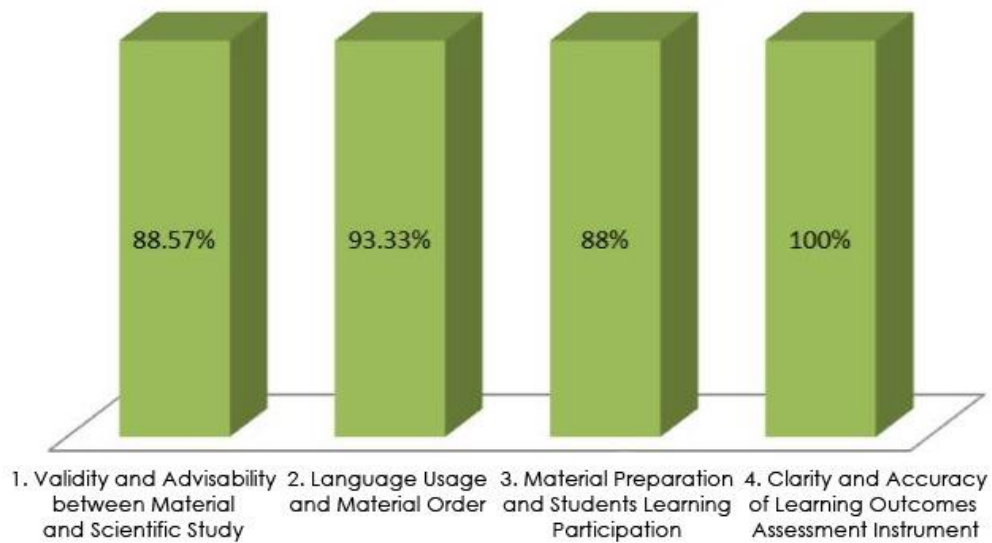


Figure 3. Graph of Validation result from Material experts

3) Media experts

The validation result from media experts toward instructional material drafts is illustrated in figure 4.

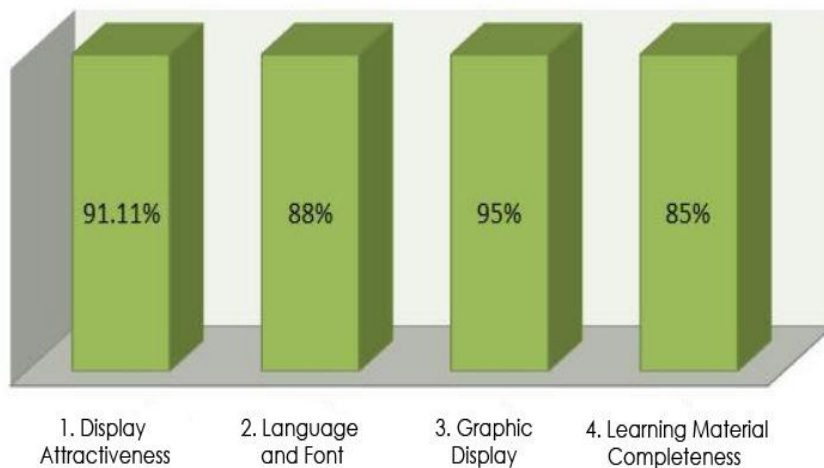


Figure 4. Validation results from media experts

4) Experts' revision and suggestion

a) Revision from Experts of educational design

Pictures and graphs must be presented in text and must be clear. Further, the language must be clear and understandable. The activity order is adjusted with

TIK order so that it will appear each step in every activity that reflects TIK activity determined.

b) Revision from Media Experts

There are some corrections in instructional materials they are: typing and picture layout. Those parts has been repaired and approved by materials experts so that it is recommended for the next examination that is one to one test.

c) Revision from instructional media Experts

Instructional media experts suggested that the color combination must suitable. Further, it has been approved by instructional media experts and it continues to one to one learner test.

b. One to one leaner

One to one learnertest results were obtained from assessment was illustrated in Figure 5.

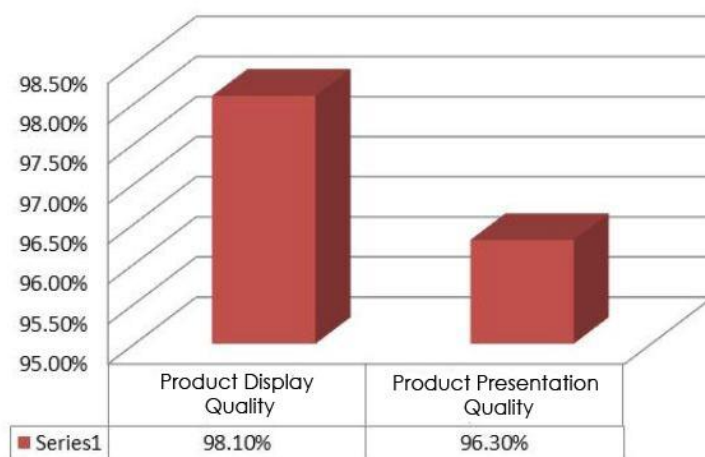


Figure 5. *One to One Learner Test* result.

c. Small group Test

Subjects' response toward small group test that was obtained based on indicator determined. It is illustrated in figure 6.

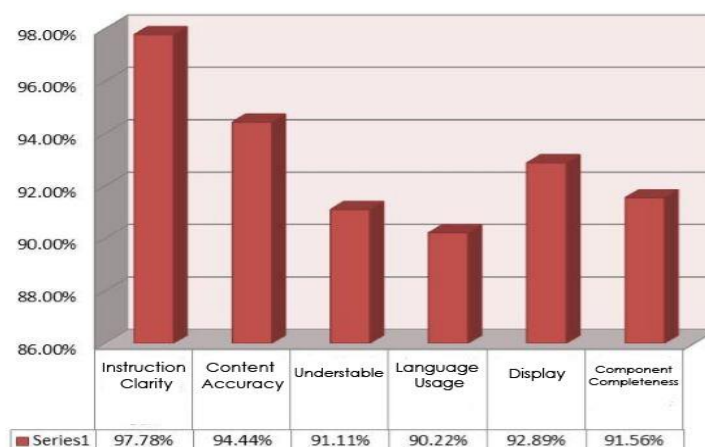


Figure 6. Subjects' response toward small group

b. Field trial test

The result of field trial test was in score of 7 indicators is illustrated in figure 7.

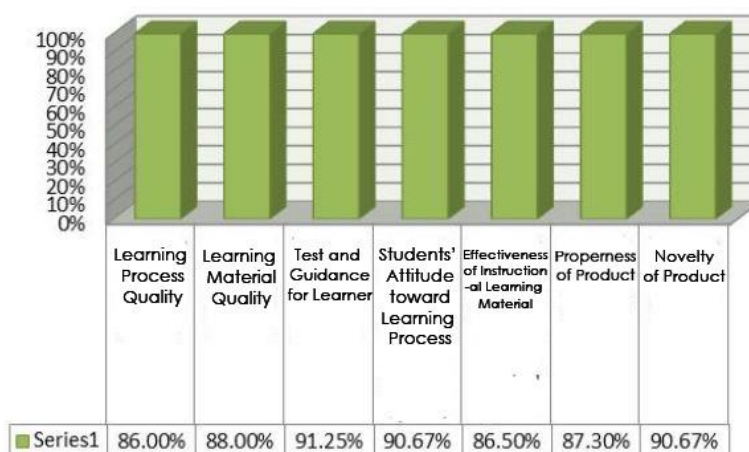


Figure 7. Field trial response

5. Discussion

5.1. Role of Learning materials

Lecturers in Teachers and Educational Science Faculty (FKIP) Batanghari University, Jambi still use a general book and references. They do not use specific and special book that becomes mathematics learning materials. So that the students still confuse and the materials are not maximally conveyed. This shows that the mathematics teaching materials still need to be examined and evaluated. Besides, the examination of material and students' characteristic is still required.

The development of teaching materials must be examined from several aspects such as user (students), materials, strategies, learning and evaluation. Teaching materials subject has an important role in learning process because it is a source and guide to achieve target determined in every subject. Moreover, learning materials is the infrastructure to achieve instructional achievement determined. Based on this condition, it requires innovation that developing teaching material that suits with materials, students' characteristic and ability.

5.2. Procedure of Instructional material development

The procedure of Instructional Material Development following some steps based on the situation of mathematics instructional development. The step is started by analysing students need. It implies that students still require specific instructional material because the instructional media used is still general. The aims are described in instructional analysis to determine competence that must be mastered by students. Moreover, the next step is required to analyse students' characteristics and students' initial skill so that it can be predicted. Further, the determination of specific instructional objective is required to achieve general objective determined so that it can determine materials used. The process of application requires instructional strategy development that becomes guide in applying instructional materials. Thus, finally instructional material development can be done and examined to assess its qualification. Further, it needs formative evaluation step to assess instructional material developed.

6. Conclusion

In implementation of mathematics instructional media subject, the lecturers were using general books of instructional media which is not specific for mathematics instructional media. The procedure in designing and developing mathematics instructional media, using Instructional Development Model is used to develop instructional materials in the form of books. The formative evaluation results from some validations of experts concluded that the development product of mathematics instructional media in the subject has been done based on recommendation from products used. Further, it was continued with one to one examination, small group and field trial. The results of all examination resulted good results

so that the mathematics instructional media was properly to be used. It is hoped that the result of this study can help to improve the way teachers or lecturers in conveying the materials during teaching activity in class.

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Percentage contribution of each author in the manuscript

Zulyadaini - 100%