TEACHING MATERIALS DEVELOPMENT BASED ON *PROJECT* OF MATHEMATICS INSTRUCTIONAL MEDIA

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Abstract

Media particular mathematics teaching aids in schools today limited both the number and type. Conditions props that there are many who are in a state of disrepair. Reviews These conditions resulted in the need for a teacher's ability to conduct independent props. Seeing Reviews These problems, it is Necessary to prepare prospective teachers of mathematics are Able to develop and Utilize props **mathematics.** This research aims to develop teaching materials based *project* to improve the ability of student teachers of mathematics in the development and use of props mathematics. This study uses a research model of development stages using five items, namely information-gathering phase, the planning phase, the product development stage, trial phase, and the phase of product improvement. Learning experts declared valid enough teaching materials (67.7%). Media experts claim valid teaching materials (76.7%). Expert evaluation declared valid teaching materials (76%). On small scale trials (4 students) teaching material declared fit for use (75.9%). In a large-scale trial (10 students) teaching material declared fit for use (77.6%).

Keywords: Teaching Materials, Project, Instructional Media, Mathematics

INTRODUCTION

Math only known as a science is taught to develop numeracy skills. Actually, the teaching of mathematics not only emphasized on numeracy, but also on mathematical concepts with abstract objects. Objects are abstract mathematical can not be observed with the five senses. Media of mathematics especially props in the form of real objects (concrete) can be used as a tool for students to think abstractly. abstract concept mathematics presented in the form of concrete will be able to to be understood by students.

Teachers as the spearhead of learning should be able to use props as a medium of learning in mathematics. The capability of determining the starting materials that require the use of props, selecting the right props, and the manipulate props. The reality on the ground, the teacher faced with the availability of props owned the school. Based on a needs analysis project report props junior mathematics in 2015 by students of the fifth semester the *Muhammadiyah* University of *Sukabumi*, some junior high schools in the city and district of *Sukabumi* still lack props. Props in the school is limited both the number and type. Conditions props are also many who are in a state of disrepair. Procurement props through school procedures take a long time. These conditions resulted in the need for a teacher's ability to conduct independent props.

Muhammadiyah University of *Sukabumi* (UMMI) has the Faculty of Education (Guidance and Counseling), which also contained the study program (Prodi) Mathematics Education as a printer prospective teachers of mathematics. Prospective math teachers are targeted to be able to teach in middle and high school education. Seeing the problems of props, then Prodi Mathematics Education needs to be responsive to prepare prospective teachers of mathematics are able to utilize and develop the junior high school mathematics teaching aids. Through courses, Media of Learning Mathematics, Mathematics Education the major can train students to be able to use and develop mathematical props.

Teaching materials as one aspect in learning Mathematics Instructional Media needs to be restructured in order to improve the ability to use and develop mathematical props. The ability to utilize and develop the props include the ability to analyze the need props for junior high school math materials, selecting the right props concept, draft props including tools and materials as well as how to use, assemble props, and simulate props. To facilitate the students get a learning experience that will form these capabilities, the teaching materials that need to be arranged is *project-based* teaching materials. *Project-based* teaching materials are expected to

make the students gain experience learned directly in *SMP* environment. The ability to utilize and develop the props will be controlled for students plunge and face the real problems in the field. Need to be designed and selected *projects* in the instructional materials that the student activities more focused, effective and produce products props.

LITERATURE REVIEW

Teaching Materials

The teaching material is a medium to achieve the desire or goal to be achieved by learners (Ward, 2010: 29). The teaching material is something that contains a message of learning, either specific or a general nature that can be exploited for the sake of learning (Mulyasa, 2006). The teaching material is a source of learning in the form of visual or audiovisual that can be used as an alternate channel of communication in the learning process, the teaching materials according to the *National Center for Vocational Education Research Ltd/National Center for Competency-Based Training* is all kinds of materials that are used to help teachers/instructors in carrying out the teaching and learning activities in the classroom (socialization SBC, 2009). Based on those opinions, it is a teaching material in this study that is a set of means of the visual form (print) containing the message of learning to achieve learning objectives.

Learning Based Project

Model learning based project constitute one of learning models concerning centralization question and problem that meaningful, problem-solving, the basis for taking a decision, process search various source, giving the opportunity to a member working in collaboration, and closes with the presentation product (Thomas, 2000). Characteristic model based learning on project supports are: 1) the student makes framework; 2) there is a problem whose solution is not predetermined; 3) students devised to achieve results; 4) The student is responsible for obtaining and managing the information collected; 5) students conduct continuous evaluation; 6) the students look back at what they do; 7) The end result is a product (Wena, 2010: 145). Model learning based Project (MPBP) have advantages as environment learn: (1) authentic contextual *(Goal-directed activities)* will strengthen relationship between activity and conceptual knowledge that underlies it, (2) forward autonomy learning *(Self-regulation)* and teacher as a preceptor and partner of learning that will develop skills of productive thoughts, (3) collaborative learning which provides the opportunity learning mutual that increases comprehension conceptual and skills technically, (4) realistic, oriented learn active solve real problem, who gave contribution at Developing prowess breaking problem, (5) give return internal that could sharpen skills (Kamdi, 2008).

Media of Learning Math

The medium of learning is defined as all objects that become intermediaries in the learning. All objects are used as a tool in the learning of mathematics called mathematical props (Sukayati and Suharjana A., 2009: 6). According to Djoko Iswadji, props math is a set of concrete objects designed, manufactured, assembled or arranged deliberately which is used to help install or develop concepts or principles in mathematics (in Pujiati, 2004: 3). The main function is to lower props abstractness of the concept so that children are able to capture the true meaning of concepts be learned (Sukayati and Suharjana A., 2009: 7). In general, the function of the props are: 1) as the media in imparting mathematical concepts; 2) as the media in establishing the understanding of the concept; 3) as a medium to show connection between mathematical concepts with The world around us as well as the application of the concept in real life (Pujiati, 2004: 4). General principles of the use of props, including the following:

1. The use of props should be in accordance with the purpose of learning.
2. Visual aids which are used should be in accordance with the method/strategy learning.
3. There is no one visual aid that can be appropriate for all kinds learning activities.
4. Teachers need to be skilled in using visual aids in learning.

5. The viewer used must be in accordance with the student's ability and style learning.
6. Selection of props should be objective, not based on pleasure personal.
7. The successful use of props is also affected by the conditions environment. (Sukayati and Suharjana A., 2009: 9)

METHOD

This study refers to the steps performed by Borg & Gall which was later modified into stage information gathering, planning, product development stage, and the stage trials.

Phase I: Information collection

At this stage, the study should be done regularly and description of the analysis of the findings. The study of literature conducted on the units show lecture/subjects mathematics learning media. Studies conducted on the standards of competence, basic competence, course descriptions, course objectives, and indicators of learning. At this stage of the analysis the description of the findings, the results of previous research on the analysis of the basic skills to explain aspects of media use student learning in the implementation of Professional Training Program (PLP) were analyzed for then arranged a teaching materials are expected to be set in the alternative solution of the research findings.

Phase II: Planning

At this stage, the design of the product design teaching materials. From some sources stating components of teaching materials, selected components of teaching materials that will be used in this study.

Phase III: Product Development

Stages of product development done by arranging the content of each component of the design of teaching materials.

Phase IV: Tryout Test

In the pilot phase carried out design validation, design revisions, product testing, product improvement, and conclusion. Validation of the design is done by three experts consisted of learning experts, media experts, and expert evaluation. Validation of teaching materials is done with validator material and validators instructional media were analyzed using descriptive techniques percentage by the following formula.

$$P = \frac{f}{N} \times 100\%$$

Information:

P = percentage score
f = number of scores obtained
N = the number of maximum scores

Validator learning, evaluation, and media will answer questions by giving a score corresponding rubric validation (highest score = 5 and the lowest score = 1). Conversion of quantitative data with qualitative to 5 scales using the following rules.

Table 1. Convert Data to Data Quantitative Qualitative

Range Value (%)	Qualitative criteria	Information
85 -100	very valid	without revision
70-84	valid	without revision
55-69	Enough invalid	minor revisions
50-54	Less Vaid	major revision
0-49	Very less valid	major revision

Revised design is done with reference to the advice of experts who validate instructional materials to obtain a product of teaching materials. After revision of the design, the products produced in the first trial of 4 students (users) with the details of 4 students on small scale trials and 10 students on a large-scale trial. Student feedback regarding the use of teaching materials was taken using a questionnaire. The questionnaire contains questions with excellent choice answers (SB), good (B), sufficient (C), less (K) and very less (SK). Each answer was scored as follows SB = 5, B = 4, C = 3, C = 2, SK = 1. The results of student responses were analyzed using the following formula.

$$P = \frac{f}{N} \times 100\%$$

Information:

P = percentage score
f = number of scores obtained
N = the number of maximum scores

Expected outcomes user response is determined by converting qualitative data into quantitative data by using a 5-point scale following rules.

Table 2. Conversion to Quantitative Data Qualitative Data

Range Value (%)	Qualitative criteria	Information
85 -100	very feasible	without revision
70-84	feasible	without revision
55-69	fairly feasible	minor revisions
50-54	Less feasible	major revision
0-49	Very less feasible	major revision

Data from these students then, it was analyzed to do repairs on the product when necessary. After repairs (if any), and then the researcher concluded the result.

RESULTS AND DISCUSSION

Teaching materials developed in this study was the teaching materials project-based learning media. First made in stages information collection that includes literature, and description of the analysis findings. The next step was the planning stage. At this stage, the design of the product design teaching materials. The next stage was the development of products. This phase was done by arranging the content of each component of the design of teaching materials. The last stage was a tryout test. In the pilot phase carried out design validation, design revisions, product testing, product improvement, and conclusion.

Phase I: Information Gathering

Study of Literature

Based on the literature study conducted on subjects Unit Class Events math learning media obtained information as follows.

a. Competency standards
   Students will be able to use and develop junior high school mathematics teaching aids.
b. Basic competence
   1) Analyzing the needs of junior high math props.
   2) Identifying props that are already available and that does not exist.
   3) Choosing props junior high math.
   4) Using props junior high school mathematics.
   5) Developing props junior high math.

c. Course Description
   This course discusses the mathematical props as a medium of learning mathematics Junior High School *(SMP)*.
d. Aim
   Students can gain additional knowledge and skills of props as a medium of learning mathematics in junior high. Knowledge and skills expected to be a provision for student teachers to enhance the professional competence of teachers in using and developing mathematical props.
e. Indicator
   Indicators of student achievement in the study of this course is that students are able to use and develop junior high school mathematics teaching aids.

Description of The Findings of The Analysis

In the research that has been done before by Nurcahyono, NA and Dauphine, E. (2015) on the analysis of student teaching basic skills PLP (Professional Training Program) with samples of two students who teach in junior high, it is known that explains the basic skills in using instructional media indicator (props) still has not mastered.

Phase II: Planning

There are several opinions about the components that must be present on teaching materials. In this study, teaching materials developed in the form of modules. The elements that must exist in the module include:

1. Teacher Manual,
2. Student Activity Gazette,
3. Work Gazette,
4. Locks Work Sheet,
5. Tests Gazette
6. Key test Gazette,

In addition, according to Sudjana, the components of a module is also governed by the Education Ministry. The module contains at least about:

1. Hint learning (Hint student / teacher) Â
2. Competence to be achieved
3. *Content* or material content
4. supporting information
5. Exercises
6. Work instructions, can be Worksheet (LK)
7. Evaluation
8. Feedback on evaluation (MONE, 2010)

Based on those two opinions, the initial design of teaching materials that will be developed include the following components:

1. Competency standards
2. Basic competencies
3. Brief Description of Course
4. Aim
5. Indicator
6. Scope
7. How Teaching Material Utilization
8. Large projects
9. Matter
10. Small projects
11. Exercise
12. Summary
13. Bibliography

These project-based teaching materials, so that the elements of project-based learning are incorporated into the design of teaching materials.

Phase III: Product Development

Stages of product development done by arranging the content of each component of the design of teaching materials. Standards of competence, basic competence, course descriptions, objectives, and indicators based on the literature of the unit show lecture math learning media. The scope of the material in these materials include:

1. INTRODUCTION contains Course Description, Competency Standards, Competency, Interest, Indicators, Scope and Method Teaching Material Utilization.
2. CHAPTER II MEDIA LEARNING MATHEMATICS discusses: Learning Media Definition, Types of Instructional Media, Media Benefits of Learning, Learning Media Selection and Evaluation of Instructional Media.
3. CHAPTER III discusses TOOL FIGURE MATH: Math Definition Viewer tool, Function Viewer tool, used Interest Viewer tool, General Principles of Use Viewer tool, Requirements Viewer tool, and Miscellaneous Viewer Tool Math.
4. CHAPTER IV ANALYSIS TOOL FIGURE NEEDS MATH discusses Selection Viewer Tool.
5. CHAPTER V DEVELOPMENT PLANNING TOOL FIGURE MATH It discusses the development steps props mathematics.
6. CHAPTER VI USE OF TOOL FIGURE discusses Failure Usage Viewer Tool.
7. CHAPTER VII CLOSING contains the Summary and Key Answer Exercise.

How to use teaching materials divided into two instructions for lecturers and instructions for students. The major project in the teaching materials is fluorescent mathematics which is done student for one semester by meeting certain requirements obtained from a small project. The material on this teaching material includes media mathematics, props mathematics, analysis of needs props mathematics, planning development props mathematics, and the last use of props. Exercise in this teaching material is placed at the end of the chapter. The summary contains the essence of any material and projects are undertaken students. This teaching material was also completed by an attachment that contains format project report and an assessment format.

Phase IV: Tryout Test

Design Validation

Validation is done by three experts, namely learning experts, media specialists, and experts evluasi. Here is a list of experts who validate the initial design of teaching materials in this study.

Table 3. Validator List

No.	Name	Programs/Specialization	Areas of expertise
1	Drs. Djadja Djadjuri, M.Pd.	Curriculum development	Expert of Learning
2	Luthpi Saepulah, M.Pd.	Education technology	Expert of Media
3	Aritsya Imswatama, M.Pd.	Mathematics education	Expert of Evaluation

Based learning experts, from 13 aspects assessed gained 9 points premises score of 4 and 4 grains with a score of 2. In order to obtain a range of values 67.7%, which means validator stated quite valid (minor revision). Revisions were made regarding:

a. Correspondence between the basic competencies with indicators of learning outcomes.
b. Clarity (goal) indicators to be achieved
c. Completeness of information
d. Suitability of project tasks with indicators of learning outcomes.

Validator also provides the following advice:

a. Interest may be incorporated into the formulation Competency Standards adjusted.

b. Basic competence can be reordered (systematic)
c. Indicators more detailed than the basic competencies.
d. Provides step learning early in the project.

Based media expert, from 12 aspects assessed obtained 3 items with scores of 5, 6 points with a score of 4, 1 point with a score of 3, and 2 points with a score of 2. So that the range of values obtained 76.7%, which means validator declared invalid (without revision). However, there are suggestions as follows:

a. Use of *the font/type* must be consistent
b. Figure given captions
c. Illustration/image needs to be improved

Based on the expert evaluation of the 10 aspects assessed gained 8 points with a score of 4 and 2 points with a score of 3. In order to obtain a range of values 76%, which means validator declared invalid (without revision). However, there are suggestions as follows:

a. Projects and materials are not written in one chapter, but if you want to be a project evaluation tool then it is written on sub-chapter evaluation
b. Exercises at the end of each chapter adjusted by Indika tor achievement of each chapter.

Revised Design

After validation of the design, the next stage of improvements to the design in accordance with the advice of experts to reduce the weaknesses found. Repairs were carried out:

a. Adjust the basic competencies with indicators of learning outcomes.
b. Indicator (goal) to be achieved is described in more detail (chapters)
c. Jot indicators of learning outcomes at the beginning of each project task
d. Interest merged into Competency Standards
e. Reorder basic competence
f. Provides step learning early in the project.
g. Using *font/type* consistently
h. Giving captions on each picture
i. The project is written in the sub-chapter evaluation
j. Jot achievement indicators in each chapter

Tryout Test of Product

a. Small-Scale Field Tryout Test

Small-scale field trials conducted by distributing questionnaires to users that some of the students who take courses in learning media (4 students). The trial is conducted to determine whether the products have both aspects of the feasibility study, the content, the display making it feasible to use. Summary of test results to the user is shown the following table.

Table 4. Results of small-scale trials

No.	Aspect	results Validation				
		SK	K	C	B	SB
1	Include instructions for use	0	0	0	4	0
2	Explaining the objectives to be achieved	0	0	0	2	2
3	The material is easy to understand	0	0	0	2	2
4	Provide enough practice	0	0	2	2	0
5	Exercises given in accordance with the material provided	0	0	0	3	1
6	Correspondence between materials with a given project	0	0	3	0	1
7	Clarity project description	0	0	1	3	0
8	Correspondence between projects and aspects of project appraisal	0	0	2	1	1
9	Illustrations, drawings, photos	0	0	1	3	0

10	View design	0	0	2	2	0
11	The use of fonts, type, and size of the print paper on teaching materials	0	0	1	3	0
12	*Lay out* or layout on the printed teaching materials	0	0	1	2	1
13	Linguistic	0	0	1	3	0
14	Clarity of instructions in the teaching materials	0	0	0	3	1
15	Raises the reader's interest	0	0	4	0	0
16	Motivating to learn	0	0	3	1	0
17	The ease of use of teaching materials	0	0	2	2	0
	total	0	0	23	36	9

Based on a questionnaire gives to 4 students (users), acquired a percentage of 75, 9% (feasible).

b. Large-Scale Field Tryout Test

Large-scale field trials conducted by distributing questionnaires to users that some of the students who take courses in mathematics learning media (10 students). The trial is conducted to determine whether the products have both aspects of the feasibility study, the content, the display making it feasible to use. Summary of test results to the user is shown the following table.

Table 5. Results of Large-Scale Trial

No.	Aspect	results Validation				
		SK	K	C	B	SB
1	Include instructions for use	0	0	0	7	3
2	Explaining the objectives to be achieved	0	0	0	8	2
3	The material is easy to understand	0	0	1	5	4
4	Provide enough practice	0	0	1	8	1
5	Exercises given in accordance with the material provided	0	0	1	7	2
6	Correspondence between materials with a given project	0	0	2	6	2
7	Clarity project description	0	0	2	6	2
8	Correspondence between projects and aspects of project appraisal	0	0	6	2	2
9	Illustrations, drawings, photos	0	0	5	3	2
10	design view	0	0	6	3	1
11	The use of fonts, type, and size of the print paper on teaching materials	0	0	1	6	3
12	*Lay out* or layout on the printed teaching materials	0	1	4	4	1
13	linguistic	0	0	0	9	1
14	Clarity of instructions in the teaching materials	0	0	4	3	3
15	Raises the reader's interest	0	0	9	1	0
16	Motivating to learn	0	0	4	6	0
17	The ease of use of teaching materials	0	0	1	9	0
	total	0	1	47	93	2 9

Based on the questionnaire gives to 3 students (users), obtained a percentage of 77.6% (worth it).

Revised Product

After small-scale field trials and large scale, the next stage is revision products according to the data obtained. Revision products is done when the user real conditions there are flaws and weaknesses. But based on testing small and large trials that stated teaching materials feasible then not be revised back.

CONCLUSIONS

Conclusions from the study material development project-based learning media of mathematics are:

1. Teaching materials developed sufficiently declared invalid by learning experts
2. Teaching materials developed declared valid by media experts and expert evaluation
3. Teaching materials developed declared fit for use by students (users)

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