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Manipulatives Implementation For Supporting Learning Of
Mathematics For Prospective Teachers

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Abstract. Manipulatives are needed by teachers to facilitate students understand of mathematics which is abstract. As a prospective mathematics teacher, the student must have good skills in making manipulatives. Aims of this study is to describe the implementation of learning courses of manipulative workshop in mathematics education courses by lecturer at Universitas Muhammadiyah Semarang which includes the preparation of learning, general professional ability, the professional capacity specifically, ability of self-development, development class managing, planning and implementation of learning, a way of delivering the material, and evaluation of learning outcomes. Data collection techniques used were questionnaires, interviews, and observation. The research instrument consisted of a questionnaire sheet, sheet observation and interview guides. Validity is determined using data triangulation and triangulation methods. Data were analyzed using an interactive model. The results showed that the average value of activities in preparation for learning, fosters capabilities of general professional, specialized professional, self-development, manage the classroom, implementing the learning, how to deliver the material, and how to evaluate learning outcomes are 79%, 73%, 67%, 75%, 83%, 72%, 64%, and 54%, respectively

1. Introduction

Advances in mathematics education characterized by increased learning tools for students in understanding the mathematical sciences. Accordingly, teachers are constantly ¹ find ways to enhance their teaching to help students understand mathematics. In recent years, there has been an increase in the use of manipulatives in the mathematics teaching [1-5]. Research in educational [6-8] had shown that when manipulatives were used effectively ², students able to construct their mathematical understanding which in turn can be a valuable learning experience. They can connect their ideas and then integrate their mathematics knowledge so that

they gain a deep understanding of mathematical concepts by many different ways.

The National Council of Teachers of Mathematics (NCTM) strongly encourages the use of manipulatives as a tool for students to create an understanding of mathematical concepts, and students actively construct new knowledge from experience and prior knowledge ³ [9]. Many studies [2,7,10-12,] support the use of manipulatives for teachers in the teaching of mathematics. They believe that manipulatives are very important in helping students improve their ability to provide a cognitive model for not only the abstract mathematical ideas but also the abstract ⁴ mathematical processes. In fact, other researchers [13-17] emphasized the importance of using manipulatives in the long-term use because it is more effective ⁵ than short-term use.

The student in university as preservice teachers should develop teachers' knowledge and skills in the implementation and development of appropriate resources, materials and technological approach. The aim of this study is to describe the implementation of the course of manipulatives workshop. Student's

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perception was discussed. This study was focused on the

¹ Overused word: *constantly*

² Overused word: *effectively*

³ Repetitive word: *knowledge*

⁴ Repetitive word: *abstract*

⁵ Overused word: *effective*

implementation of the undergraduate course of manipulatives workshop at Universitas Muhammadiyah Semarang.

2. Method

This is a descriptive analytic research with the sample population were all students at the Department of Mathematics Education semesters 4 and 6 totaling 93 students. Samples were taken at random by using Purposive Random Sampling in students who have taken courses of math manipulatives workshop, totaling 36 students. Observation, interviews, and questionnaires are used as data collection techniques. Observations ⁷ carried out to obtain a description in detail about the condition of the implementation of learning mathematics manipulatives workshop. Interviews with students and a lecturer of course in mathematics manipulative workshop ⁸ conducted by referring to the lattice [18] to obtain information about the implementation of learning mathematics manipulative workshop.

There are eight components that are measured in the questionnaire, namely the preparation of lecture, general professional competence, specific professional competence, the ability of self-development, ability to manage the class, planning, and implementation of learning, delivery of subject material, and the way to evaluate learning outcomes. The questionnaire design refers to the guidelines provided Schwarz [19], Lucas and Baird [20], Crocker and Algina [21], Krosnick [22], and Braun et.al [23]. Four answers choices were provided in the questionnaire namely very often, often, rarely, and very rarely with the scoring for each answer is 4, 3, 2 and 1, respectively. The questionnaire results for each component is analyzed using the formula below [24]:

Percentage of answers

Amount of respondent answers

Ideal score answer

⁶ Unoriginal text: 46 words
www.nrel.gov/docs/fy17osti/67542.pdf

⁷ Repetitive word: *Observations*

where ideal score = maximum score x amount of questions
x amount of respondents.

Criteria for assessment questionnaire refers to the
criterion ⁹ of Riduwan [24]. Data were analyzed using
triangulation techniques which combine and generalize the
results of the data into the form of
descriptive sentences detailed and candid. According to
Riduwan [24], the criteria for the percentage range of
100-80, 80-61, 60-41, 40-21, and 20-0 is very good ¹⁰,
good, fair, poor ¹¹, and very poor,
respectively.

⁸ Repetitive word: *workshop*

3. Result And Discussion

Three students did not return the questionnaire.
Perception of the 35 students who return the
questionnaire ¹² is presented in Table 1.

TABLE 1. The students' perceptions of the implementation
of the lectures

Assessment component

Percentage (%)

Criteria

Preparing for learning

79

Good

General professional competence

73

Good

Specific professional competence

67

Good

The ability of self-development

75

Good

Ability to manage the class

83

very good

Planning and implementation of

72

⁹ Repetitive word: *criterion*

¹⁰ Weak adjective: *good*

¹¹

Good
learning

Overused word: *poor*

Delivery of subject material

64

Good

The way to evaluate learning outcomes

54

Fair

¹² Repetitive word: *questionnaire*

Component 1. Learning plan

Results shown in Table 1 was confirmed through interviews and observations. Learning plan with a percentage of 79% and good¹³ criteria indicate that lecturers always deliver the learning objectives in each meeting. However, from the questionnaire detail, it can be shown that learning plans were always¹⁴ taken but not implemented in detail¹⁵, learning to use the main reference book without the support of additional

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references. It should be fixed on the preparation component is additional supporting books so that students can have a wider¹⁶ knowledge.

Component 2. General professional competence

The total scores obtained from four question is 376 with the ideal score is 512. In other words, the percentage of 73% with good criterion. This result describes that the lecturer has always encouraged students to understand mathematical concepts and cultivate an attitude of reasoning that can design appropriate manipulatives material. Students suggest that the lecturer can further grow fighting spirit and competitiveness among students.

Component 3, Specific professional competence

The data in Table 1 on components for general professional skills can also be described that the total score is 346 with an ideal score of 512. This result was confirmed in interviews and observations include the habit of thinking objectively and openly, exemplary attitudes, habits appreciate the aesthetic and religious values. Feedback from students to lecturer is, even more, emphasis on the teaching of habits in logical abstract thinking, systematic and creative.

¹³ Overused word: *good*

¹⁴ Repetitive word: *always*

¹⁵ Repetitive word: *detail*

Component 4, The ability of self-development

Components ¹⁷ of an ability ¹⁸ of self-development shown in Table 1 obtained a score of 388 with an ideal score of 512. Based on results of this questionnaire, interview and observation can be described that lecturers always develop themselves regarding knowledge and attitude of learning, develop appropriate skills of science and technology. Things need to be improved is the ability to develop ¹⁹ knowledge and attitudes for further studies not yet visible in learning.

Component 5, The ability to manage the class

Based on the results shown in Table 1 questionnaires, interviews and observation, the ability ²⁰ of the faculty in classroom management can be described that the very good ²¹ academic atmosphere is created at each meeting, and the spirit of the students to ask successfully developed. Lecturers also to train students to be responsible and respectful to others. Student feedback given to the lecturers for improvement is the ability of lecturers to train ²² students to critical thinking skills need to be pursued more intensively.

¹⁶ Overused word: *wider*

Component 6. Planning and implementation of learning

Table 1 shows that the planning and implementing learning was done well. These results have been confirmed by interviews and observations. Planning and implementation of learning ²³ can be described

that the learning plan is created for each meeting, learning executed sequentially from the material of manipulative design, lesson plan of manipulative and the practice of manipulative making.

Component 7. Delivery of subject material.

Good criterion with the percentage of 64% as shown in Table 1 indicate that the material is delivered with an efficient, clear ²⁴, and students actively participate in the practice of manipulative making.

However, from interviews and observations, there is an important ²⁵ note to be addressed in the limited time of the meeting led to some of the material cannot be delivered, the time for discussion in completing the task students are not provided with sufficient while students are always given the task group or individually. Regarding improving the delivery of content, students asked lecturers to create media that can assist students in developing the skills of manipulatives making.

¹⁷ Repetitive word: *Components*

¹⁸ Repetitive word: *ability*

Component 8. The way to evaluate learning outcomes Lecturer considered sufficient (54%) regarding learning outcomes evaluation design that includes assessment, reporting and practice the use of manipulative. Group work given by lecturer led to an objective assessment ²⁶ was difficult ²⁷ to carry. Assessment of learning outcomes for the task presented that can be represented by one member, causing some students are not able to assess the results of their own learning.

¹⁹ Repetitive word: *develop*

²⁰ Repetitive word: *ability*

²¹ Weak adjective: *good*

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The very good ²⁸ value in classroom management component indicated that the lecturer could create a pleasant lecturing atmosphere so that students do not get bored with the learning process. In other words, In the

²² Repetitive word: *train*

learning process, the lecturer always foster the student's spirit to understand the material well. While fair in the evaluation component indicates that only some groups are evaluated by lecturers so that students are not evaluated ²⁹ could not find out his mistake in judging themselves. In addition to assessments by the lecturer does not involve students so less objective assessment ³⁰. Overall assessment component has reached a good ³¹ category, with an average acquisition value for the eight components ³² amounted to 70.87% and included a good ³³ category ³⁴.

²³ Repetitive word: *learning*

Through the evaluation of the work on the effectiveness of using math manipulatives, the author found many works ³⁵ that supported the use of virtual [25,26,27], pictorial [28,29], and concrete [30,31] manipulatives. For decades, many authors have been demonstrating the good ³⁶ impact of using pictorial and concrete math manipulatives for their students. The works that are more coeval have extended these findings to virtual manipulatives. Although some works ³⁷ have reported unimportant when using math manipulatives, it appears that these results are related with the method used of instructional. The lecturer who adheres the best practice recommendations for manipulative used tends to undergo positive outcomes.

²⁴ Overused word: *clear*

²⁵ Overused word: *important*

4. Conclusions

As a conclusion, this study showed that the learning process for a workshop of mathematics manipulatives course had done well by the lecturer. This creates a great ³⁸ opportunity for students at the University as a prospective teacher develop their implicit conceptions about the teaching and learning of mathematics. This learning process can lead to increased confidence by obtaining a new learning experience. This learning process is the mechanism driving change belief-systems for students who use manipulatives to reveal the conception of teaching and learning mathematics. It can also help teacher monitor the process ³⁹ of reflection and to help students understand abstract concepts into concrete.

²⁶ Repetitive word: *assessment*

²⁷ Overused word: *difficult*

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²⁸ Weak adjective: *good*

²⁹ Repetitive word: *evaluated*

³⁰ Repetitive word: *assessment*

³¹ Overused word: *good*

³² Repetitive word: *components*

³³ Overused word: *good*

³⁴ Repetitive word: *category*

³⁵ Repetitive word: *works*

³⁶ Overused word: *good*

³⁷ Repetitive word: *works*

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³⁸ Overused word: *great*

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³⁹ Repetitive word: *process*

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