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Manipulative Identification Created by Preservice Mathematic Teacher

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Abstrak. Preservice mathematics teachers need to develop their competence, especially professional competence. Professional competence is related to the ability of preservice teachers to use mathematical manipulatives. Mathematics manipulatives can show real mathematical objects so that mathematics learning becomes meaningful. Preservice mathematics teachers can also design and create manipulatives as needed. This research is qualitative descriptive research. This study describes the types and uses of mathematical manipulatives made by preservice mathematics teachers in the Pekalongan University Mathematics Education Study Program. The results showed that there were 10 mathematical manipulatives with various uses, including understanding mathematical concepts, solving math problems, and playing math games. This mathematical manipulative can be used for learning mathematics, so it is necessary to test the effectiveness of the mathematical manipulative. These trials could involve schools and mathematics teachers. Lecturers should also analyze the difficulties of preservice mathematics teachers when making mathematical manipulatives so that appropriate assistance can be given according to the type of difficulty. Teachers also need to design learning in mathematics learning media courses that are more interesting so that mathematical manipulative products can be utilized by mathematics teachers and students gain in-depth knowledge of mathematical concepts.

Key words: Preservice teacher, Manipulatives, Mathematics

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INTRODUCTION

Mathematics teachers must understand subject content, instructional approaches, and assessment of learning outcomes in order to acquire 21st century abilities. Innovation is required for Indonesia's sustainable growth in the twenty-first century (Tohir, 2020). Mathematical teachers must be innovative in order to increase their competency, which includes inventing and creating mathematics aids. Teacher must have four competences: pedagogic, personality, social, and professional competence (Departemen Pendidikan Nasional, 2005). One of the competences of preservice mathematics teachers is professional competence, which is the teacher's capacity to understand learning materials extensively and profoundly so that they can help students to achieve the stated competencies. It is particularly associated with the ability to use teaching aids, measuring tools, calculating tools, tools, computer software, mathematical models, and statistical models (Dirgantoro, 2018).

Mathematical manipulatives are used as teaching aids to make mathematics learning more meaningful. One of the purposes of learning mathematics is to make it meaningful (Fuadi et al., 2013; Furner, 2017). Mathematics is an abstract subject, hence learning it is challenging. Many researchers provide suggestions for reducing mathematical abstraction so that mathematical concepts can be understood (Baroody et al., 2019; Furner, 2017; Kelly, 2006). Manipulatives can represent mathematical things in real-world terms. Manipulatives are concrete objects such as blocks that are used to teach mathematical ideas or to aid in the execution of mathematical operations (Laski et al., 2015). Concrete manipulatives are manipulative instructional tools that assist youngsters in developing their activities, exploring, and thinking critically. According to research, when manipulatives are utilized successfully, kids may create mathematical understanding, which can beuseful learning experience. Students may link their thoughts and then integrate their mathematical knowledge to develop a thorough comprehension of mathematical topics in a variety of contexts (Cockett et al., 2015; Kelly, 2006; McNeil & Jarvin, 2007; Şandır, 2016). As a result, preservice mathematics teachers must be able to design and create concrete manipulatives as a professional competency.

A course that focuses on teaching how to design and build physical manipulatives, that is the topic of math learning media. Preservice mathematic teachers create a variety of

mathematical manipulative media. The purpose of this article is to explain many types of mathematical manipulatives designed and made by preservice mathematics teacher enrolled in Pekalongan University's Mathematics Education studies program. Different types of mathematical manipulatives created by prospective mathematics teachers can be utilized as references for other teachers and prospective mathematics teachers to use for more meaningful mathematics learning.

METHODS

The research method used is descriptive qualitative. The qualitative descriptive approach is a research approach in which the data collected is in the form of words, pictures, and not numbers (Moleong, 2005). The research subjects were preservice mathematics teachers who were taking the Mathematics Learning Media course. The purpose of this study is to describe various kinds of mathematical manipulatives designed and made by preservice mathematics teachers in the Mathematics Education study program at Pekalongan University. Data was collected by means of observations, interviews and structured assignments. Data obtained from observations was analyzed descriptively and qualitatively.

This study describes the types of mathematical manipulatives made by preservice mathematics teachers in the Mathematics Education study program at Pekalongan University during the past year. This mathematical manipulative is identified according to the purpose of making mathematical manipulatives. Interviews were also conducted with preservice mathematics teachers to obtain information related to the purpose of making these mathematical manipulatives.

RESULTS AND DISCUSSION

Preservice mathematics teachers have the chance to design and produce mathematical manipulatives in groups during the course on mathematics learning media. Three to four persons make up one group. The lecturer analyzes the current school curriculum before providing instructions for each group to create mathematical manipulatives. According to each group's curriculum study, different forms of mathematical manipulatives have been created and constructed by preservice mathematics teachers. Mathematical manipulatives can be made from a variety of materials. Some mathematical tools are made of durable materials, whereas others are not.

At first, preservice mathematics teachers looked for the concept of unrestricted manipulative creativity. They try to find alternative ideas by reading books or conducting online searches because some ideas don't fit with the mathematical concepts taught in high school. Additionally tailored to the concept of constructing manipulatives are the materials utilized to create them. The manipulatives created by preservice mathematics teachers underwent a number of changes. In a group setting, preservice mathematics teachers talk about the need for adequate mathematics manipulatives with the lecturer in mathematics learning media.

Following discussion, the prseservice mathematics teacher soulds design mathematical manipulatives and creates them. Table 1 shows ten different types of mathematical manipulatives created by preservice mathematics teachers enrolled in Pekalongan University's Mathematics Education Study Program. According to the data, preservice mathematics teachers continue to use materials that are not durable and are easily damaged when used, such as styrofoam and paper. Based on table 1, the researchers classified mathematical manipulatives based on their intended use, namely manipulatives for understanding concepts, solving problems, and playing games.

Table 1. Types of Mathematical Manipulatives

No	Name Manipulatif	Bahan	Kegunaan
1	Monopoli Lingkaran Matematika	Wood and paper	Studying circle material using monopoly game
2	Trigonometri Smartwheel	Wood and paper	Solve related questions using the formula for the sum and difference of sin, cos, and tan.
3	SmartVenn Board	Styrofoam and paper	Understand the concept of Venn Diagrams and solve problems about Venn diagrams
4	Aljabar Daun (Alda)	Styrofoam and	Solve problems related to Algebra material

		paper	
5	Ular Tangga Balok dan Kubus	Paperboard	Learn Blocks and Cubes using the Snakes and Ladders game
6	Kotak Refleksi dan Rotasi (Kolesi)	Paper	Solve problems related to geometry transformation material (reflection and rotation)
7	Fun Venn Diagram	Styrofoam and paper	Understand the concept of Venn Diagrams and solve problems about Venn diagrams
8	Roda Turunan (Rotan)	Styrofoam and paper	Solve problems related to derivative material
9	Roda Pintar Trigonometri	Wood and paper	Solve related questions using the formula for the sum and difference of sin, cos, and tan
10	Ular Tangga Bangun Ruang (Ubar)	Styrofoam and paper	Studying the material for building space using the game of snakes and ladders

Table 1 shows some mathematical manipulatives that have the same purpose but are only named differently. Consider Trigonometri Smartwheel and Roda Pintar Trigonometri are both used to solve problems related to the formula for the sum and difference of sin, cos and tan. The SmartVenn Board and Fun Venn Diagram are then introduced, both of which are used to understand the concept of Venn Diagrams and solve problems with Venn Diagrams. Preservice mathematics teachers should be shown examples of mathematical manipulatives so that they can generate ideas for creating their own. According to interviews, preservice mathematics teachers do not have enough time to create mathematical manipulatives, so the ideas for creating manipulatives vary.

Mathematical manipulatives must be tested before they can be used in schools. Manipulatives may serve as tools for teachers to translate abstractions into a form that enables learners to relate new knowledge to existing knowledge (Moyer, 2002). Teachers are expected to guide students' representational processes using these manipulatives. This is a challenge for teachers and can be used as research material in the future.

CONCLUSION

The manipulatives made by preservice mathematics teachers vary, although there are similarities in the uses of these mathematics manipulatives. Based on the classification, there are 10 types of mathematical manipulatives with various uses. Researchers classify the types of mathematical manipulatives based on their uses, namely understanding concepts, solving problems, and palying games. This mathematical manipulative can be used for learning mathematics, so it is necessary to test the effectiveness of the mathematical manipulative. These trials could involve schools and mathematics teachers. Lecturers should also analyze the difficulties of preservice mathematics teachers when making mathematical manipulatives so that appropriate assistance can be given according to the type of difficulty. Teachers also need to design learning in mathematics learning media courses that are more interesting so that mathematical manipulative products can be utilized by mathematics teachers and students gain in-depth knowledge of mathematical concepts.

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