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The growth of mathematical imagination of students of a deaf school when learning using Problem-Based Learning assisted by manipulative teaching aids

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ABSTRACT

The ability of mathematical imagination is important in daily life for children with deaf disabilities. One effort to foster mathematical imagination is through a problem-based learning model assisted by manipulative props. This study aimed to: (1) find out whether the results of the mathematical imagination final test of deaf students with the application of the Problem-Based Learning assisted by manipulative props are better that the results of the initial test; (2) describe the mathematical imagination of the deaf students; (3) find out the growth of mathematical imagination of the deaf students. This research was mixed-method research that used a sequential exploratory design with a one-group pretest-posttest design. The population of this research was the students of a special school for disabilities (SMALBN) in Salatiga, Indonesia, while the sample was a random class from the 11th classes. The method used in this research were observation, documentation, tests, and interviews. Quantitative analysis showed that the final test of mathematical imagination result was better than the results of the initial test. Qualitative analysis yield a description of mathematical imagination that included aspects such as scientific sensitivity, scientific creativity, and good scientific productivity. The scientific sensitivity aspect of the imagination growth before learning was good, and the scientific creativity aspect was quite good. After learning, it was obtained that scientific sensitivity, scientific creativity, scientific productivity were good. The study concluded that problem-based learning assisted by manipulative props could foster the ability of mathematical imagination of deaf students in 11th grade.

1. Introduction

Education is essentially a conscious and planned effort to create an atmosphere of learning so that students actively develop their potential to become human beings who have faith and devotion to God Almighty, have a noble character, are healthy, knowledgeable, capable, creative, independent and become democratic citizens as well as responsible (Ministry of National Education, 2003). Inclusive education is defined as a system of education that provides opportunities for all students who have abnormalities and can have the potential for intelligence and / or special talents to attend education or learning in an educational environment together with students in general (Aziz et al., 2015). Law Number 8 of 2016 concerning persons with disabilities who experience physical, intellectual, mental and / or senoric limitations for a long period of time in interacting with the environment can experience obstacles and difficulties to participate fully and effectively with other citizens on equal rights. APD who experiences disability is certainly a factor of consideration in determining an innovation that will be carried out. One of the features that really needs an innovation in the learning process is Deafness. To create an innovative learning atmosphere, the teacher

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is expected to have three attitudes in developing mathematics learning; namely, the teacher must at least know the nature of mathematics, the nature of a child, and how to teach mathematics based on existing theories (Mariya et al., 2013). In the 2013 curriculum, mathematics subject must be given to all levels of education (Aziz et al., 2015). Mathematics subject needs to be given to all students to develop students' thingking skills and provide an understanding of basic mathematical knowledge (Satoto et al., 2013).

Imagination is an interesting activity that is often carried out by every human being. This is done to stimulate, grow, and improve the potential of intelligence and creativity of children in their growth period. Imagination is considered an important ability in solving a problem (Gunadi, 2017). Vygotsky (2004) identifies that four ways connect imagination with reality. Imagination is an important function for human life. First, imagination comes from someone's experience. Second, the results of one's imagination have a relationship with real life. Third, the function of imagination and reality is related to emotions, so each emotion has the capacity to trigger impressions that have been realized externally becomes a real form. So, it can be concluded that imagination skill is very important for students. From the results of interviews and observations, it was obtained that the ability of mathematical imagination of deaf students in class XI-B in SMALB Salatiga was still low.

According to Mariya, et al. (2013) stated that choosing the right learning model must pay attention to the condition of the students, the nature of the material of teaching materials, available media facilities, and the condition of the teacher itself. The learning model influences students in understanding the material including fostering the ability of mathematical imagination from the teacher's material. For PBL learning to be more easily understood and attract students' interest, learning will be better when using problems that exist in the surrounding environment, especially the local culture where students live. Hence, students are not frustrated and bored in attending mathematics learning (Abdulloh et al., 2015). Therefore, the researcher was interested in using one of the learning models that is problem-based learning model assisted by manipulative props. In implementing PBL in school, the teacher can apply the syntax as follows: (1)The teacher prepares questions that meet the requirements as a matter of expressing students' abilities. (2) The teacher explains the algorithm that has not been notified to students. (3) The teacher provides routine practice questions. (4) The teacher asks students to work on the problems used to reveal the students' abilities in solving problems. (5) After the teacher checks the students' work, the teacher takes care of solving the problem in front of the class (Pujiastuti et al., 2018). According to Kosasih (2014), the learning model based on student's problems is related to the KD being studied. Based on this description, the problem-based learning model where problem-based learning can foster students' mathematical imagination. The steps of the problem-based learning model, according to Arends (2012), are (1) providing orientation about problems to students; (2) organize students to research; (3) assist independent and group investigations; (4) developing and presenting results; and (5) analyze and evaluate the problem-solving process.

According to Mariya et al. (2013), the effectiveness of learning is not only determined by the learning model used, but the proper use of media will be able to maximize learning outcomes and one of the media is the teaching aids used in mathematics learning. Learning for SLB students who use teaching props in a fun and mathematical atmosphere seems easy. The use of manipulative teaching props accompanied by the application of appropriate learning models is expected to help teachers grow the imagination of students to achieve the learning objectives formulated (Sugiman et al., 2018).

Pujiastuti and Mashuri (2017) suggested that teaching props can assist in planting concepts, understanding concepts, proving formulas, and practicing skills. In addition, the use of teaching props can also increase students' motivation to learn. Props in the learning process are tools that teachers use in communicating with students to create an effective teaching and learning process. The props play an important role because they can streamline the learning process. In accordance with what was revealed by Sudjana (2014), props play an important role as a tool to create an effective teaching and learning process. Therefore, the researcher used manipulative props with indicators (1) introducing, correcting, increasing, understanding of concepts and facts, (2) facilitating abstraction, (3) having non-harmful forms, (4) having attractive colors.

The ability of mathematical imagination in this study consisted of several aspects and indicators, according to Mun (2015), indicators of mathematical imagination ability can be seen in Table 1.

Table 1. Indicators of Mathematical Imagination Ability

Aspects	Indicators
Scientific Sensitivity (SS)	*Emotional understanding*
	The experience of imagination
Scientific Creativity (SC)	*Diversity*
	Originality
Scientific Productivity (SP)	*Creation and reproduction*
	Scientific sense of reality

This study aimed to find out: (1) whether the results of the mathematical imagination final test of deaf ADP students with the application of the problem-based learning model assisted by manipulative props are better that the results of the initial test; (2) description of mathematical imagination; (3) the growth of mathematical imagination.

2. Methodology

This type of research is quantitative and qualitative research. The research design used was Pre-Experimental Design, which was used in the form of One Pre-test Post-test Design. This study population were deaf students in SMALB Salatiga with a sample of 8 students of class XI deaf.

Before conducting research, the researcher first determined the material to be given, namely integer operations, developing learning implementation plans for the implementation of the discovery learning model assisted by manipulative teaching props, compiling research instruments in the form of written tests and interviews. The methods used in this study were the method of observation, documentation, tests, and interviews. Quantitative data analysis began with a normality test and then continues with tests that aim to find out whether the final test results of the ability of mathematical imagination of deaf students with the application of problem-based learning models assisted by manipulative teaching props were better than the initial tests of mathematical imagination. The normality test criteria are to accept H_o if $L_o < L_{table}$ with a value of $\propto = 0{,}05$. It was followed by a t-test with the test criteria rejecting H_o if $t' \geq \frac{w_1 t_1 + w_2 t_2}{w_1 + w_2}$. In addition, the steps for analyzing qualitative data were data reduction, data display, and conclusion. Qualitative data analysis aimed to determine the description of mathematical imagination and the growth of the ability of mathematical imagination in a model of problem-based learning assisted by manipulative teaching props.

3. Finding and Discussion

3.1. Findings

The study began 2018 by conducting observations and interviews to find out the learning activities used in SLB Negeri Salatiga, the characteristics possessed by SLB Negeri Salatiga students in general and especially for deaf students.

The next step was to conduct an initial test of students' mathematical imagination abilities and interviews to confirm the ability of mathematical imagination based on test results. After that, the researcher conducted a study with a model of problem-based learning assisted by manipulative props with the material used was integer operations. After the material is finished, the final test of mathematical imagination is done by interview.

The results of the initial and final mathematichal imagination were then analyzed quantitatively.

3.1.1. Quantitative Data Analysis

3.1.1.1 Normality Test

The normality test used the final test results of the ability of mathematical imagination. Normality test using the Liliefors test. The normality test results can be seen in table 1.

Table 2. The Normality Test Result

Data	L_o	L_{table}
The Result of Imagination Ability Final Test	0,2968	0,319

From the data, it was obvious that $L_o = 0{,}2968 \leq L_{table} = 0{,}319$, thus H_0 was accepted, which meant such data came from a normal distribution population.

3.1.1.2 Hypothesis Test

Hypothesis testing was done by comparing the results of the initial test scores and the final test of mathematical imagination's ability using the t-test. Hypothesis test results can be seen in Table 2.

Table 3. The Hypothesis Test Result

Data	t'	$\frac{w_1 t_1 + w_2 t_2}{w_1 + w_2}$
The result of initial and final test of imagination ability	4,73	2.23

From the data, it was obvious that $t' \geq \frac{w_1 t_1 + w_2 t_2}{w_1 + w_2}$, then rejected H_0, which meant that the final test results in the ability of mathematical imagination were better than the initial test of the ability of mathematical imagination.

3.1.2. Qualitative Data Analysis

By comparing the results of the initial mathematical imagination with the results of interviews on the subject B-01, B-03, and B-05, it was shown that the scientific aspects of sensitivity were fulfilled quite well. In contrast, scientific creativity and scientific productivity aspects have not been fulfilled. In subject B-02 the scientific sensitivity aspects and scientific creativity were fulfilled quite well. At the same time, the scientific productivity aspects have not been fulfilled. Furthermore, for subject B-04, the scientific aspects of sensitivity, scientific creativity, and scientific productivity have not been fulfilled. So that on subject B-04, there is no aspect of imagination that is fulfilled. Thus, subject B-06 has aspects of scientific mathematical imagination sensitivity and quite good scientific creativity.

The final test results of the ability of the subject's mathematical imagination B-01, B-03, B-04, B-06 were good scientific sensitivity aspects, scientific creativity was quite good, and scientific productivity was good. Subject B-02 had aspects of the imagination ability; good scientific sensitivity, scientific creativity, and scientific productivity. Subject B-05 had aspects of mathematical imagination ability of good scientific sensitivity, quite good scientific creativity, and quite good scientific productivity.

3.2. Discussion

3.2.1. Test Results for Student Mathematical Imagination

Based on the score of the initial and final test of the mathematical imagination ability, the test results after using the problem-based learning assisted by manipulative teaching props were better than the initial test of mathematical imagination's ability. Students' learning outcomes had increased; this could be seen from students' learning outcomes.

3.2.2. Description of Mathematical Imagination

Based on the results of tests and interviews, the subject B-01, B-03, B-05 had the ability of mathematical imagination Emotional Understanding (EU) scientific aspects of sensitivity. Thus, the subject B-01, B-03, 05 were students who can explore the difficulties of mathematical problems. Subject B-01, B-03 had not been able to solve problems obtained from experience / recalling the rules of completion, finding new steps in resolutions apart from what the teacher gave, finding new strategies found that can be applied in solving similar problems, finding new strategies with basis, and transferring abstract problems into concrete.

Subject B-02 showed that subject B-02 had had the ability of mathematical imagination *Understanding* (EU) *scientific sensitivity aspect* and *Diversity* (D) *scientific creativity aspect*. Thus, subject B-02 was a student who could explore the difficulty of mathematical problems and solve problems comes from experience / recall a settlement rule without making new or slightly modifying solutions, on the other hand subject B-02 had not been able to find new strategies found that can be applied to solve similar problems, find new strategies on the basis, and transfer abstract problems into concrete.

Subject B-04 had no aspect of mathematical imagination that appeared. Thus, the subject of B-04 did not have the ability of mathematical imagination *Emotional Understanding* (EU), *The Experience of imagination* (EI) *scientific sensitivity aspect*; *Diversity* (D), *Originality* (O) *scientific creativity aspect*; *Creation and Reproduction* (CR), *Scientific sense of reality* (S) *scientific productivity aspect.*

Subject B-06 had the ability of mathematical imagination of Diversity (D) aspects of scientific creativity. Thus the subject of B-06 was a student who was able to find new steps in completion apart from what the teacher gave, but the subject of B-06 beam was able to explore the difficulties of the problem, solve problems obtained from experience / recall the rules of completion, find new strategies found can be applied in solving similar problems, finding new strategies based on, and transferring abstract problems into the concrete.

3.2.3. The Growth of mathematical imagination

The ability of mathematical imagination of deaf students based on aspects of imagination according to (Jiyeong Mun et al., 2015), before learning using the problem-based learning model assisted by manipulative teaching props was Emotional Understanding (EU), The Experience of Imagination (EI) aspects of good scientific sensitivity and scientific aspect Diversity (D) creativity was quite good. Whereas after learning by using a problem based learning model assisted by manipulative props, there was an increase in the Emotional Understanding (EU), the Experience of Imaginatio (EI) aspects of good scientific sensitivity; Diversity (D), Originality (O) aspects of scientific creativity are good; Creation and Reproduction (CR), Scientific sense of reality (S) aspects of scientific productivity are good.

4. Conclusion

Based on the results of research on the application of problem-based learning models assisted by manipulative teaching props to foster mathematical imagination of deaf students in class XI-B in SMALB Salatiga 2018/2019 academic year, it can be concluded that the results of the final test of mathematical APD Deaf ability with problem based Learning assisted by manipulative teaching props were better than the initial test of the ability of mathematical imagination. Description of the mathematical imagination of class XI-B students at SMALB Negeri Salatiga was that scientific sensitivity aspect was good that was shown by Emotional Understanding (EU), The Experience of Imagination (EI) was achieved; good scientific aspects of creatifity were shown by Diversity (D), Originality (O) was achieved; good aspects of scientific productivity were indicated by Creation and Reproduction (CR), Scientific sense of reality (S) was achieved. The growth of mathematical imagination in students was that during the initial test good scientific sensitivity aspects, the scientific aspects of creativity were quite good and the scientific aspects of productivity were not achieved. Whereas after learning there was an increase in good scientific sensitivity aspects, the scientific aspects of creativity were quite good, and scientific productivity aspects were good.

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