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Understanding Ability of Mathematical Concepts and Students' Self-reliance towards Learning by Implementing Manipulative Props (APM) on Jigsaw Technique

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Abstract

According to observations and interviews conducted towards fourth grade students of Elementary School 2 Sendangmulyo, the researcher found that students' understanding of concepts and self-reliance were low. Purpose of this study were to identify the effectiveness of manipulative props (APM) on jigsaw technique in learning process; to improve students' understanding of mathematical concepts; and toanalyse students' self-reliance in Mathematics learning by implementing manipulative props on jigsaw technique observed from their ability in understanding the concepts. This study used mixed method by applying concurrent embedded research design. As a result, implementing manipulative props on jigsaw technique in learning process could improve the students' understanding of mathematical concepts. It could be seen from the average number improvement of students' understanding of mathematical concepts of 30.44 so that there were 92% of students improved their understanding of concepts after the technique was implemented. According to the students' self-reliance category, students who have high understanding of concepts was showed to be in high category, students who have moderate understanding of concepts was indicated to be in medium-high category, while students who have low understanding of concepts was proven to be in medium-low category.

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INTRODUCTION

Mathematics is one of basic knowledge which both applied aspect and reasoning are useful for mastering knowledge and technology (Abidin & Saputra, 2011). One of the keys in learning Mathematics is the mastery of concepts (Fatqurhohman, 2016). In Mathematics there is an initial concept as the basis for understanding the next concept (Susilo, et al. 2015). Mathematics learning is done by observing the sequence of concepts starting from the simplest to the most complex concepts. A good understanding in the previous concept is important in order to understand the new concept. Furthermore, to achieve the success of learning process students are required to master the concept.

Understanding of concepts is a process, method, or action to understand or to know in detail the concepts being studied, this is reflected in students' learning outcomes (Setyowati, et al. 2015). Understanding of concepts that students have is one of the cognitive learning outcomes obtained by students through the learning process (Suryani, et al. 2016). Conceptual understanding can generally be interpreted as the ability of students to understand concepts, restate concepts in their own language, and relate the concepts to one another in everyday life. Students' self-reliance in their own abilities influences how students apply the concepts they have understood in their daily lives.

Self-reliance is one certain attitude that must be possessed by students. Self-reliance could be interpreted in believing in one's own abilities, being independent in making decisions, and less longing to be over-praised by others. According to Prastowo (2017), self-reliance indicators are sense of optimism, objectivity, responsibility, independence, and courage to express opinions without any interruption from anyone. Self-reliance could encourage students to express their ideas to solve the problems they face (Rizqi, et al. 2016).

Mathematics is one of the subjects that most of elementary school students fear of it because it has abstract learning objects (Prasetyawan, 2016). It causes lack of confidence for the second-semester fourth graders of Elementary School 2 Sendangmulyo, Sarang, Rembang in the academic year of 2016/2017 because of the low learning outcomes. It happened on the final test in which there were 26 out of 43 students of fourth graders of Elementary School 2 Sendangmulyo who got scores under the minimum score of 60 (KKM). According to the interview activity carried to five students, it was concluded that the students did not understand the material conveyed by the teacher, especially when the material was abstract, because the teacher only gave lectures and assignments from books, so learning was considered less attractive by the students. In addition, the results of interview with subject teacher stated that the students' self-reliance when answering questions or carrying out the learning process was low, students were hesitant in making decisions and this caused many students to cheat on their friends' works.

Regulation no. 22 of 2016 issued by Minister of Education and Culture states that skill competence could be obtained from presentation activities through scientific approach. Therefore, the researcher applied Jigsaw technique to help students presenting the mathematical concepts they have received. In presenting students' mathematical concepts, it requires self-reliance.

Students' self-reliance in communicating the concepts to their friends could be implemented if the students have really understood the concepts. One of the learning model which suitable to the purpose is Jigsaw learning model. Learning by using Jigsaw technique is mentioned as cooperative learning that requires students tp explain the concept that has been learned to their friends. Cooperative learning is a deep learning strategy that divides students into small groups with different learning abilities (Yaduvanshi & Singh, 2015). In cooperative learning, students do not just sit and cooperate in doing the tasks given by the teacher (Astuti & Barratt, 2018) otherwise they reinforce and explore each other to increasingly master the materials being studied (Wahyudi, et al. 2012). Aronson (Slavin, 2014) stated Jigsaw as one

example of cooperative learning where there are origin groups and expert groups with various learning topics. One group of experts is responsible for mastering a particular material and is able to teach the material to members of the origin group (Nasruddin & Abidin, 2017). Hedeen (Thomas & Setiaji, 2014) concluded in his study that the main purpose of Jigsaw learning was to learn cooperative skills. In conclusion, Jigsaw is one example of cooperative learning that emphasizes group learning in which every student is required to master a learning concept to be shared with other members of the group.

Jigsaw technique enhances students' learning motivation and self-reliance as well as develops communication skills and improves students' achievement (Marhamah & Mulyadi, 2013), scientific attitudes and understanding of concepts (Nardi, et al. 2015). Jigsaw technique improves students' self-efficacy and learning activities (Alfurofika, et al. 2013). In addition, according to Yoonkyung & Yongseob (2015) jigsaw technique not only fosters students' creativity but also students' care and cooperation with others. One of the example of innovations in this model is using manipulative props (APM). Props are mediators or introductory learning messages where this media could optimize all five senses of students (Widiyatmoko & Pamelasari, 2012). Props help learning process to be more effective because it could be easily understood by the students (Indriyanti & Widiyaningrum, 2014).

Lintang, et al. (2017) concluded that APM are all objects used as tools or equipment to facilitate students in understanding the concepts and procedures. Learning becomes interesting and fun by applying APM (Hidayah, et al. 2016). Learning Mathematics assisted by using manipulative props not only facilitates students to find concepts but also strengthens scientific approaches, even in the attitude development (Hidayah, 2018). To sum up, APM are teaching aids or tools that could be developed by the students so that it could concretize abstract materials and make learning process be more effective and enjoyable.

In accordance with the Piaget theory, elementary school students are still in the concrete operational phase. Then it is compulsory to have props or media that could reduce the abstractness of Mathematics learning, so that the material could be easily understood by the students. For instance, Mathematics learning about angle and geometry (plane). One of the goals of geometry learning is to develop students' self-reliance (Kartono, 2010). This study was conducted to determine the effectiveness of manipulative props on Jigsaw technique to improve students' understanding of concepts and self-confidence analysis in terms of ability to understand mathematical concepts about angle and geometry.

METHODS

Research method in this study was using mixed method. The researcher used concurrent embedded research design. As we know that concurrent embedded research design has primary method to assist the research and secondary method to support the research (Sarwi & Rusilowati, 2013). In this study, the researcher used quantitative research as primary method while qualitative research as secondary method. In one hand, source of quantitative data obtained from written test in the form of short-answer questions. On the other hand, students' learning observation, interviews after learning process, and students' self-reliance questionnaires were obtained as the qualitative data for this study. There were 34 students of fourth grade of Elementary School 2 Sendangmulyo were decided as experimental group and there were 34 students of fourth grade of Elementary School 2 Sendangmulyo were decided as control group. The quantitative data obtained then being analyze by using IBM SPSS 23 software. In analyzing the data, the researcher conducted normality test, paired samples t-test, as well as N-gain test. In analysing the qualitative data, the researcher collected the data from questionnaires, observations, as well as interviews.

RESULTS AND DISCUSSION

Results of this study showed that students' understanding of mathematical concepts on pre-test results of control and experimental group did not differ significantly, yet for post-test results of control and experimental group differed significantly. Table 1 indicated the pre-test and post-test results of control and experimental group.

Table 1. Ability to Understand Concepts on Pre-test and Post-test Results of Control and Experimental Group

	Pre-test		Post-test	
	Control	Experimental	Control	Experimental
Mean	48.09	35.59	44.41	66.03
Average score	45	35	45	65
Lowest score	10	10	10	30
Highest score	75	65	70	95

Normality tests were performed because the use of parametric inferential statistics requires that the data that was being analysed must be normally distributed. The results of the normality test are presented in Table 2 below.

Table 2. Normality Test on Understanding the Concepts on Pre-test and Post-test Results of Control and Experimental Group

	Class	Kolmogorov-smirnov[a]			Shapiro-wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Pre-test	Control	0.139	34	0.093	0.940	34	0.061
	Experimental	0.135	34	0.118	0.957	34	0.193
Post-test	Control	0.103	34	0.200	0.962	34	0.282
	Experimental	0.144	34	0.073	0.953	34	0.149

*. This is a lower bound of the true significance.
a. Lilliefors significance correction

The hypothesis for normality test is H_0 if the data is normally distributed and H_1 if the data is not normally distributed. Decision making criteria is obtained if Sig. > α then H_0 is accepted and if otherwise, H_1 is accepted with $\alpha = 0.05$. Based on Table 2, it could be seen that all data is normally distributed.

Paired samples t-test was used to prove the difference in the average value between understanding of concepts assisted by APM in PBL (control group) and in Jigsaw learning (eksperiment group). To find out if there was an improvement, it could be seen from the gain value (post-test minus pre-test). The results of the paired samples t-test using the gain value could be seen in Table 3 and4 as follows.

Table 3. Results of Improvement in Concepts Understanding of Control and Experimental Group

	Mean	N	Std. deviation	Std. error mean
Gain control group	-3.68	34	10.753	1.844
Gain experimental group	30.44	34	12.270	2.104

From Table 3 above, it is shown that the average value of students' improvement in understanding the concepts for control group is -3.68, which means that there was no improvement in understanding the Mathematics concepts in the control group. While average value of students' improvement in understanding the concepts for experimental group is 30.44.

Table 4. Paired Samples Correlation

	N	Correlation	Sig.
Gain of control & Experimental group	34	.139	.433

From Table 4 above, it could be seen that the coefficient correlation between the concepts understanding on control and experimental group was 0.139 with the value of Sig. 0.433 which was greater than 0.05. This means there was no correlation in understanding of concepts between control and experimental group.

The paired samples t-test results showed that the t_{value} obtained was equal to -13.132 with the Sig. equal to 0.000. The data analysis showed that $t_{value} < t_{table}$ was $-13.132 < -2.035$ so that H_0 was rejected. So, the conclusion is that there was a difference in the average value of students' understanding of mathematical concepts improvement between the control and experimental group.

The improvement test was carried out with the aim of knowing the value of average improvement in understanding of mathematical concepts on experimental group students before and after applying manipulative props in Jigsaw technique using the Gain Normality <g> formula. Gain Normality Value <g> obtained was translated by the following acquisition criteria: $\langle g \rangle \leq 0.30$ included in the low category, $0.30 < \langle g \rangle \leq 0.70$ included in the moderate

category, and $0.70 < \langle g \rangle \leq 1$ in the high category. The improvement in students' understanding of mathematical concepts occurs if the value of Normality Gain <g> is in the minimum of moderate category.

Based on the calculation, it was obtained the value <g> in the experimental group with a high category of 4 students, moderate category of 27 students, and low category of 3 students. So the improvement value of students' understanding of mathematical concepts was 92%. Based on the data above, it could be concluded that implementing APM in Jigsaw technique was effective to improve students' understanding of mathematical concepts. This was in line with the results of research conducted by Alpian & Anwar (2017), Afrisetya & Santoso (2016), Mutlu (2018), and Márquez, et al. (2017) that APM in Jigsaw technique was effective to improve students' understanding about concepts.

Students' self-reliance profile analysis was based on the ability to understand mathematical concepts. This ability is divided into three abilities, namely the ability to understand high mathematical concepts, the ability to understand moderate mathematical concepts, and the ability to understand low mathematical concepts. The subjects of the study was found to be four students from each level of the ability in understanding the mathematical concepts, so that they were selected 12 research subject (SP). SP1, SP2, SP3, and SP4 from the ability to understand high concepts; SP5, SP6, SP7, and SP8 from the ability to understand the moderate concepts; SP9, SP10, SP11, and SP12 from the ability to understand the low mathematical concepts.

SP1 has high self-reliance, there were four out of five self-reliance indicators that were in the high category and one is in the moderate category. Indicators of self-reliance in SP2, SP3 and SP4 were in the high category, so that SP2, SP3, and SP4 were declared to have high self-reliance. In conclusion, students who have high self-reliance and ability to understand the concepts were categorized in the high category. It was because the four research subjects performed high self-reliance.

There were three indicators of students' self-reliance on SP6 and SP7 that were in the high category and the other two indicators were in the moderate category, so SP6 and SP7 showed high self-reliance. Two out of five self-reliance indicators on SP8 were in the moderate category and the other four indicators were in the high category, means that SP8 showed moderate self-reliance. All of self-reliance indicators on SP5 were in the moderate category, means that SP5 showed moderate self-reliance. It could be concluded that students' who have moderate self-reliance in the concepts understanding were in the moderate category.

SP9 performed moderate self-reliance with one category of self-reliance was in high category and the other four were in the moderate category. SP11 showed moderate self-reliance because there were five categories of self-reliance were in the moderate category. There were three out of five self-reliance indicators on SP10 and SP12 were in the moderate category and others were in the low category. It could be concluded that students with low concepts understanding ability have a moderate level of self-reliance.

Students who have high concepts understanding ability also perform high self-reliance, Students who have moderate concepts understanding ability also perform moderate self-reliance, and students who have low concepts understanding ability have moderate self-reliance. This was consistent with the results of Vandini's research (2015) and Agustyaningrum & Suryantini (2017) where students who have good self-reliance will get good learning outcomes. Students' self-reliance is the ability of students to believe in themselves. Eviliasani, et al. (2018) in her study concluded that self-reliance influences students' mathematical creative thinking abilities.

According to indicators above, it could be identified that the optimistic indicator of students was higher than the other indicators. Students' independence indicator was the lowest among the five indicators of self-reliance. In accordance with the research of Arismawati & Bondan (2017), they stated that the main aspects that influence students' self-reliance is optimistic aspect.

CONCLUSION

Based on the results and discussion of this study, it could be concluded that Mathematics learning by using manipulative props in Jigsaw technique in some topics such as lines, angles, and planes could effectively improve students' understanding of concepts. In addition, profiles of students' self-reliance in Mathematics learning such as lines, angles and planes were different in terms of the ability to understand the mathematical concepts. Students who have high understanding of concepts tend to have high self-reliance. Students who have moderate and low understanding of concepts tend to have moderate self-reliance. Moreover, students who have moderate understanding of concepts tend to have some indicators of self-reliance which stay in the high category. Whereas students who have low understanding of concepts tend to have several indicators of self-reliance which stay in the low category.

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