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Mathematical Spatial Ability Reviewed from Students' Self-Confidence in the PBL Model with *Teacher and Peer feedbacks* Assisted by *Geogebra*

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Abstrak

This research aims to describe mathematics spatial skill reviewed from the self-confidence of students in high, moderate, and low categories. This research was conducted in the eighth grade JHS Hasannudin 6 Semarang, in the academic year 2018/2019. This mixed-method research used a sequential explanatory strategy. It is a procedure to collect quantitative and qualitative data orderly. The technique of collecting quantitative data was done by mathematics-spatial skill test. Meanwhile, the qualitative data was done by documentation, questionnaire, and interview. The findings showed mathematics-spatial skill of each-category student's self-confidence had various mastery indicators. The students with high-self-confidence tended to be more consistent in mastering spatial visualization, spatial relation, and mental rotation. The spatial-orientation and spatial-perception aspects of high self-confidence students were sometimes successful and sometimes not successful. The moderate-self-confidence students tended to master spatial visualization, spatial relation, and spatial orientation aspects. However, there were several subjects with moderate-self confidence in the five aspects. Subjects with low-self-confidence tended to be more consistent in mastering spatial visualization and spatial perception. There were subjects with low-self-confidence who only mastered four aspects of mathematics-spatial skills.

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INTRODUCTION

The greatest challenge of Indonesian people in this fast-growing era and the global challenge is to prepare the future generation to keep up with the fast-growing rate of global changes. Educators hold an important role in creating the future generation who can keep up with the global changes and the advancement of science. One of the standard to determine a certain nation's civilization could be seen from its education. It is as stated by Nadia, Waluyo & Isnarto (2017) that education is the best means to develop civilization.

Education in Indonesia is required for its future generation, especially in formal education. Mathematics is a lesson in formal education and it must be learned. Mathematics trains students' logic to think orderly, to reason, and to argue systematically and correctly based on a mathematics-science framework (Retnowati & Aqiilah, 2017: 13).

Several students state learning mathematics is difficult (Muijs & Reynolds, 2005). Most students have difficulties in learning mathematics because of its abstract nature (Afriyani, Chotim dan Hidayah, 2014). Such difficulties have an impact on the students' failures in learning mathematics. Aszolos & Bako (2004:1) states the most difficult part of mathematics at primary and junior schools is geometry.

Student-geometry learning outcomes, especially dealing with a three-dimensional shape, are still not optimal (Darmayanti et al, 2017). Based on the previous studies, they state that there are two main difficulties experienced by students during learning geometry. They are misconceptions toward the geometry concept and principle (Ada & Kurtuluş, 2010; Kabaca, Karadag, & Aktumen, 2011; Novita & Niawati, 2016; Özerem, 2012; Sutiarso, Nurhanurawat, & Coesamin, 2008).

Another factor causing low-geometry understanding deal with high-visualization requirement since it is abstract in nature (Hanafi, 2014). The most important factor in dealing with geometry understanding is a spatial skill.

Spatial skill is a skill to analyze, visualize, understand, and express imaginative signs and forms (Kumastuti, Supartono, & Dwijanto, 2013). This skill allows students to translate their thoughts into two or three-dimensional shapes. Clements and Batista (in Panaoura, Gagatsis & Lemonides, 2007) state spatial skill is a single component that has a strong correlation to mathematics achievement. According to Fajri, Johar, & Ikhsan (2016), if a student's confidence could manage his spatial skill in learning geometry, it develops positive attitudes.

Self-confidence is a belief inside of the human spirit to engage life challenges by promoting certain things (Widyaningtyas & Farid, 2014). Low-self-confidence is experienced by students in Indonesia. Based on the questionnaire analysis result, 26.47% of students had a low-self confidence level with a percentage of less than 70% (Agustyaningrum & Widjajanti, 2013). Therefore, to improve low self-confidence students and to improve their mathematics-spatial skills requires innovation in the school-learning model.

One of the learning models that could improve geometry-learning outcome and the student-mathematics spatial skill is *Problem Based Learning* model. According to Arends (in Dzulfikar, Asikin, & Hendikawati, 2012), the PBL model is a learning model with an authentic learning approach for students. Thus, students could construct their knowledge, develop their higher skill and inquiry, make them independent, and improve self-confidence. PBL model is effective to be applied in learning mathematics, especially for geometry material. It is consistent with Mariani, Wardono, & Kusumawardani (2014). They state PBL assisted by *Mathematics Pop Up Book* is effective to improve the spatial skill of Junior High School students in geometry material.

Besides the appropriate-learning model selection, to improve innovation with the purpose to visualize mathematics ideas to be better to understand geometry, there is a need for certain combinations with certain media. The use of technological media in learning could improve the mathematics-thinking process (Zevenbergen, Dole, & Wright, 2011). Thus, students will experience a more meaningful process. One of the appropriate media with geometry material is *Gegebra.*

Geogebra is an application or computer program used as media to learn mathematics, especially dealing with geometry, calculus, and algebra materials (Fazar, Zulkardi, & Somakin, 2016).

Geogebra is effective to visualize and improve understanding (Saha et al, 2010).

Student-spatial mathematics skills should be optimized not only by the PBL model and *Geogebra* media but also by feedbacks. *Feedback* is an important component in the learning process and student development (Weaver in Bedford, 2007). *Feedback* has several types, such as *teacher feedback* and *peer feedback.*

Teacher feedback is a teacher's evaluation of his or her students. This *teacher feedback* provision in learning is an important activity to improve students' knowledge, skill achievement, achievement, and learning motivation (Sumarno, 2016). Meanwhile, *peer feedback* is feedback given by a student to each other by commenting on other students' works, behaviors, or performances (Liu & Carless, 2006). The learning process by using *feedback* provides wider insight for students to interpret the feedbacks and to support mathematics learning (Reinholz, 2018).

The problem formulations in this research are (1) how is the quality of the applied PBL model with *the teacher and peer feedback* assisted by *Geogebra* toward the eighth graders' spatial mathematics skill in class B of JHS Hasannuddin 6, Semarang, and (2) how are the descriptions of the students' spatial mathematics skill reviewed from the eighth graders' *self-confidence* at JHS Hassannudin 6, Semarang.

METHOD

This is mixed-method research. The research strategy is a sequential explanatory (Cresswell, 2016). Creswell & Clark (in Creswell (2016) states that sequential explanatory is a procedural strategy to collect quantitative and qualitative data orderly. Sequential explanatory is a procedure prioritizing quantitative data rather than qualitative data.

This research was conducted at Public JHS Hassannuddin 6, Semarang. The population of this research consisted of eighth graders of Public JHS Hassannuddin 6, Semarang. The taken samples were based on a random sampling technique with VII B students as the experimental group intervened by PBL with the teacher and peer feedback assisted by Geoboard and VII-A student as the control group intervened by discovery learning. The research subjects consisted of nine students selected based on spatial-skill categories reviewed from their self-confidence.

The qualitative data collection technique was a test. The test technique is used to obtain data about the students' mathematics spatial skills. The test questions are essay made by considering aspects of mathematics-spatial skills. The qualitative data collection techniques were done by interview, documentation, and observation. The self-confidence questionnaire consists of four indicators with 40 questions. The quantitative data analysis was done through normality and homogeneity tests to determine the hypothesis test. The hypothesis test consisted of individual and classical accomplishment test, variance average test, and proportional test. The qualitative data analysis used Miles and Huberman ((Sugiyono, 2016:338)) as the references by following these stages: (1) data reduction, (2) data display, and (3) data conclusion.

FINDINGS AND DISCUSSION

The results of the initial-mathematics spatial skill of the students resulted in the Actual Accomplishment Standard as calculated by $BTA = \bar{X} + \frac{1}{4}SD$ with $\bar{X}$ which is the class average and SD is the deviation standard (Sudjana, 2009). The Actual Accomplishment Standard of mathematics-spatial skill is 64.28. The applied-minimum passing grade criteria in PBL with teacher and peer feedbacks assisted by Geogebra were calculated based on AAS and MPG scores of the school. The MPG of the eighth grade of JHS Hassanuddin 6 Semarang is 71. The applied MPG in the learning is 66.

The quality of the PBL model implementation with the teacher and peer feedbacks assisted by Geogebra in mathematics-spatial skill is seen from (1) planning stage, (2) acting stage, and evaluating stage (Danielson, 2011).

The planning stage covers arranging stages and learning-instrument validation. The tools and learning instruments in this research consist of the syllabus, lesson plan, worksheet, feedback sheet, mathematics-spatial skill test, self-confidence questionnaire, observation sheet, and interview guideline. The validation results of the equipment and learning instruments, from three experts, resulted in an excellent category with an average score of 3.92.

The action stage was judged by observers with the assistance of an observation sheet of learning quality. The observers would assess teacher and student activities in the implementation of PBL with teacher and peer feedbacks assisted by Geogebra.

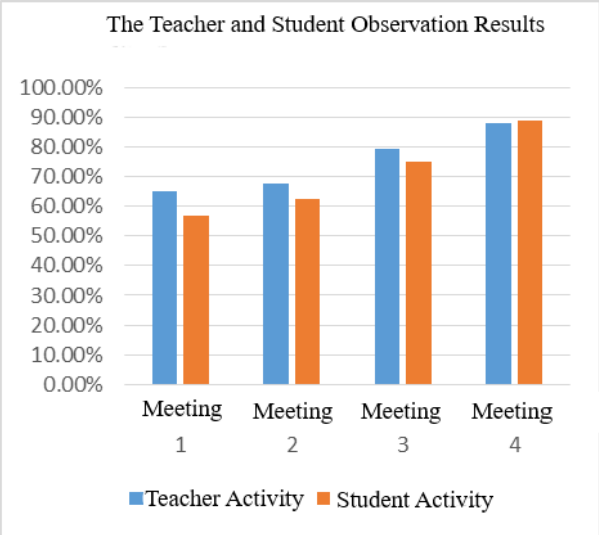

Figure 1. Teacher and Student Activity Diagram

The final-average result of learning quality is measured from teacher activities categorized excellent with a percentage of 75%. Meanwhile, the average of the learning quality was measured from students' activities categorized excellent with a percentage of learning implementation 70.83. The percentage of the teacher and student activities in each meeting increases. It means the PBL model with the teacher and peer feedback assisted by Geogebra could improve the students' mathematics spatial skills. It is consistent with Sugiyami et al (2018) statement that a lesson with PBL model implementation with Geogebra in geometry material could improve the mathematics spatial skills of Islamic students.

The learning evaluation stage was done to find out the effectiveness of PBL model implementation with the teacher and peer feedback assisted by Geogebra. PBL model with the teacher and peer feedbacks assisted by Gegebra is effective if it meets several criteria: (1) the students' mathematics spatial skill average scores in PBL model with teacher and feedbacks assisted by Geogebra reach the determined minimum passing grade; (2) the students' mathematics spatial skill average scores in PBL model with teacher and feedbacks are better than those taught by Discovery learning.

The effectiveness of mathematics spatial skills in the PBL model with teacher and peer feedbacks assisted by Geogebra had met the determined-effectiveness criteria with the processed-test data results. They are (1) the completeness criteria of the experimental group show $sig > 5\%$. It is $0{,}000 > 0{,}05$ then H_0 is denied. It means on a significant level 95%, the hypothesis stating that the mathematics-spatial skill average score is higher than 66 is accepted, (2) the results of 29 students' mathematics spatial skill reached the completeness. From 32 students, it shows $z_{count} \geq z_{table}$ or $2.041 > 1.65$. Thus, H_0 is accepted. It means 75% of the experimental group students classically reached the completeness, (3) the average difference results of mathematics spatial skill as assisted by SPSS 16.0, it shows $sig(2-tailed) = 0{,}017$. It is $0{,}017 < 0{,}05$, H_0 is denied. It means on a significant level of 95%, the students' mathematics spatial skill average scores taught by the PBL model with teacher and feedbacks assisted by Geogebra were better than those taught by the DL model. Thus, it could be concluded that the PBL model with teacher and peer feedbacks assisted by Geogebra was effective to improve the students' mathematics spatial skills in a three-dimensional flat shape. It is in line with an argument stating Geogebra is effective to construct the mathematics concept of students (Jelatus et al, 2018).

Based on the finding, the PBL model with teacher and peer feedbacks assisted by Geogebra could improve the students' mathematics spatial skills. It is consistent with an argument stating t a lesson that applies PBL implementation with Geogebra in geometry material could improve the mathematics spatial skills of Islamic students.

The qualitative analysis of this research consists of mathematics spatial skill test in the form of students' answer sheets. They were categorized into high, moderate, and low. The self-confidence questionnaire results were classified into high, moderate, and low categories. Based on the analysis, the recapitulation of self-confidence classifications and categories of the mathematics spatial skills are shown in Table 1.

Table 1. Recapitulation Results of *Self-Confidence* Classifications and Mathematics-Spatial Skill Categories

Self-Confidence	Mathematics Spatial Skill			Total
	High	Moderate	Low	
High	6	7	-	13
Moderate	2	12	2	16
Low	-	2	1	3
Total	8	21	3	32

Table 1 shows from 32 students of the experimental group, there were 8 of them categorized high-mathematics spatial skill students. The details are: students with high self-confidence consisted of 6 persons while moderate self-confidence consisted of 2 persons. Students with moderate-mathematics spatial skills consisted of 21 students. The details are 7 students with high self-confidence, 12 students with moderate self-confidence, and 2 students with low self-confidence. There were 3 students categorized as low-mathematics spatial skill*s*. The details are: students with high self-confidence consisted of 2 persons and low self-confidence consisted of 1 person. There were 9 students selected as the research subjects from each category. The subjects would be interviewed comprehensively about mathematics-spatial skills.

The indicators of mathematics-spatial skills applied in this research are based on Maier's mathematics spatial skill aspects (1998: 71). They are (1) explaining a position of shape put horizontally and vertically (*spatial perception*), (2) showing the rules of transformation or translations of a shape (*spatial visualization*), (3) rotating each part of the shape accurately and appropriately (*mental rotation*), (4) finding the parts of the shape and connecting them to the others (*spatial relation*), (5) using three-dimensional shape elements from certain perspectives (*spatial orientation*). Here are the summaries of mathematics spatial skills reviewed from student self-confidence of the students are shown in Table 2.

Table 2. The Analysis Summary of Mathematics Spatial Skills Reviewed from the Student *Self-Confidence*

Skill Classification Mathematics Spatial	Total	Aspect of Mathematisal Spatial Ability				
		SV	*SR*	*SO*	*MR*	*SP*
High	6 (H)	√	√	√	√	√
	2 (M)	√	√	√	√	√
Moderate	7 (H)	√	√	-	√	-
	12 (M)	√	√	√	√	-
	2 (L)	√	√	-	√	√
Low	2 (M)	√	√	√	-	-
	1 (L)	√	√	√	-	-

Table 2 describes students in the population who have various *self-confidence* and mathematics spatial skills.

The analysis of the subjects with high-mathematics spatial skills with high *self-confidence* shows the students tend to master five aspects. The students with moderate *self-confidence* also master five mathematics spatial skill aspects. They were facilitated by *Geogebra* media while learning, especially in geometry, since they have been experiencing difficulty in imagining certain three-dimensional flat shapes.

Students with moderate mathematics spatial skills show that students with high *self-confidence* could master three aspects. Then, subjects with moderate *self-confidence* could master four aspects. Meanwhile, low *self-confidence* students could only master four aspects. The problems experienced by high *self-confidence* students occurred while working on questions about *spatial orientation* and *spatial perception* aspects. The students could not draw a refrigerator sketch that could be seen from above and they could not determine the position of three-dimensional shape put horizontally. The problems experienced by the moderate *self-confidence* students while working on the questions about *spatial perception* aspects were that they had a difficulty in which one should be the base when the shape was put horizontally. The problems experienced by low *self-confidence* students occurred while working on questions about *the spatial orientation* aspect. The students could not draw a refrigerator sketch appropriately. The sketch drawn by the students still showed a front view of the refrigerator. Students with moderate spatial skills require more intensive guidance with the teachers. Thus, students could work on the questions.

The low-mathematics spatial skill student group with moderate *self-confidence* students could master two aspects. They were *mental rotation* and *spatial perception.* The students could not re-draw the shape. They seemed confused to rotate the shape. They also could not determine a position of shape put horizontally. Those subjects could not master *mental rotation* and *spatial perception* aspects. These inabilities were caused since they did not understand the material well and were lack of attention during learning. They were also afraid to ask the teachers about any materials they did not understand.

The implementation of the PBL model with *teacher and peer feedbacks* assisted by *Geogebra* in high and moderate *self-confidence* students seemed to be braver in expressing their ideas while having a learning process. They were also brave to ask about materials they did not understand while having a discussion. The findings are in line with a study done by Widyaningrum, Mariani, & Sutikno (2015) stating that students with high or moderate self-confidence could express their arguments during the class discussion.

The implementation of the PBL model with *teacher and peer feedbacks* assisted by *Geogebra* supports fostering effective learning to develop self-confidence and mathematics skills of students. It is because the PBL model with *teacher and peer feedbacks* assisted by *Geogebra* trains the cognitive and affective aspects of students. In this research, they are realized in mathematics spatial skill and *self-confidence.* The stages of the model could train students' mathematics spatial skills, such as developing and presenting stages, as well as analysis and evaluation stages where the students could train their mathematics spatial skills and self-confidence by discussing. It is in line with Sugiarni et al (2018) that PBL model implementation assisted by *Geogebra* make teacher and student activities are effective to improve their mathematics spatial skills and are conducive.

The learning process in the PBL model with *teacher and peer feedbacks* assisted by *Geogebra* showed the students given *feedbacks* understood better and could improve their mathematics spatial skills. Teacher and student feedbacks were given so students could listen and note the feedbacks. The students were also taught to provide feedback to their peers. It is in line with a statement that the average learning results and mathematics *self-efficacy* of students that are given feedbacks are higher than those without feedback administration (Anggrainin et al, 2015). Students who had not reached the minimum passing grade of mathematics spatial skills were given remedial chance. It was conducted at the end of each meeting.

CONCLUSION

It could be concluded that generally all mathematics spatial skills of the students were not completely influenced by student self-confidence. The students with high-self-confidence tended to be more consistent in mastering spatial visualization, spatial relation, and mental rotation. The spatial-orientation and spatial-perception aspects of high self-confidence students were sometimes successful and sometimes not successful. The moderate-self-confidence students tended to master spatial visualization, spatial relation, and spatial orientation aspects. However, there were several subjects with moderate self-confidence in the five aspects. Subjects with low self-confidence tended to be more consistent in mastering spatial visualization and relation. There were those subjects who succeeded to master four aspects of mathematics-spatial skills. The dominant factor influencing students' mathematics spatial skills is learning strategy, in this case, the PBL model with teacher and peer feedbacks assisted by Geogebra.

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