International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

http://ijpsat.ijsht-journals.org
Vol. 30 No. 1 December 2021, pp.84-94

Improving Mathematical Connection Ability through the Approach of Scientific and Reciprocal Teaching

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***Abstract*—Mathematics as a structured and systematic science implies that the concepts and principles in mathematics are interrelated with each other. Studying mathematics as a whole requires a connection (relationship) to achieve a meaningful understanding, therefore mathematical connection ability is important and needs to be improved. Experimental studies have been carried out using a scientific approach and learning with a reciprocal teaching approach on circle material. This study focuses on looking at improving the ability of mathematical connections and their interactions in students who use learning with a scientific approach and learning with a reciprocal teaching approach. The study was conducted using the Pretest Posttest Two Treatment Design in class VIII in one of the junior high schools in the city of Bandung, West Java. Analysis of research data was carried out quantitatively-qualitatively based on the entire sample or broken down by category of prior mathematical knowledge (PAM): high and low. The analysis was carried out on the improvement and interaction of students' mathematical connection abilities. The results showed that there were differences in the improvement in mathematical connection skills between students who received learning using a scientific approach and students who received learning using a reciprocal teaching approach based on students' PAM (high and low). Furthermore, the analysis of the interaction effect shows that there is no interaction effect between learning and students' PAM (high and) on increasing students' abilities.**

Keywords—improvement; connection; scientific; reciprocal teaching.

I. INTRODUCTION

Mathematics as a structured and systematic science implies that the concepts and principles in mathematics are interrelated with one another. Studying mathematics as a whole requires a connection (relationship) to achieve a meaningful understanding. This research is motivated by the lack of students' mathematical connection skills, this is in line with the findings of [1] which states that six of 23 children have a considerable capacity to make mathematical connections, while 17 others have a restricted skill. Then, another finding by [2] stated that highly capable subjects have great mathematical connections, and didactic knowledge is widely used and capable of providing alternate responses to researchers, resulting in a didactic transposition, or knowledge to be taught with knowledge. Subjects with a medium level of mathematical aptitude can grasp the problem but are not as meticulous when solving it, resulting in the underutilization of prior knowledge. Subjects with low mathematical ability grasp the problem well but are not as meticulous when addressing it, resulting in the underutilization of prior knowledge. Although the students thought the process of connecting mathematics to real-life was necessary, many thought it was not done well enough [3]. The pupils' real-life examples were largely concerning numbers, such as calculating and shopping.

A student's ability to be associated with diverse problems relating to mathematics, within mathematics, and between mathematics and things beyond mathematics is known as mathematical connection [4]. A mathematical connection is a link (bridge) that establishes or strengthens an understanding of relationship(s) between or among mathematical ideas, concepts, strands, or representations using past or new knowledge [5]. Within a mental network, mathematical connections can be thought of as components of memory structure that emerge from an individual's experiences and control the individual's response to their surroundings [6]. Indicators of mathematical connection ability used in this study refer to [7], namely: (1) Students can apply mathematics in other fields (applicative); (2) Students can apply mathematics in everyday life; (3) Students can relate one procedure to another in an equivalent representation; (4) Students can apply the relationship between mathematical topics and between mathematical topics and topics of other disciplines; (5) Students can use the relationship between equivalent concepts.

Improving the ability of mathematical connections must be supported by appropriate learning. The learning must be able to facilitate students to be able to better understand the material and be able to relate it to other materials. Many learning models are offered, one of which is learning with a scientific approach that is applied in the 2013 Curriculum. The scientific approach is utilized to provide students with a thorough grasp of numerous materials, allowing them to know and understand information that comes from anywhere, at any time, and without the intervention of the teacher [8]. Students' grasp of concepts and attitudes towards science can be improved using an effective scientific approach [9]. The scientific approach to learning outcomes employing the probing prompting technique and the problem-based learning model is found to have a positive and substantial link [10]. A scientific approach that is collaborated with an integrated inquiry learning model by the ability to think creatively is one of the factors that support the success of learning [11]. The implementation of a scientific approach has a beneficial impact on cognitive, affective, and psychomotor capabilities, also assists in the attainment of the defined classical mastery [12]. The teacher's scientific approach successfully engaged students in active learning activities and produced various students' contributions, as well as fostering critical thinking and developing high-thinking levels of students' learning behavior [13].

Learning with a scientific approach is intended to provide understanding to students in recognizing and understanding various materials using a scientific approach, as well as knowing that information can come from anywhere, anytime, not depending on unidirectional information from the teacher [14]. Therefore, the learning conditions created are expected to encourage students to find out from various sources through observation, and not just being told. Such learning conditions are also expected to make students active to understand the subject matter themselves and be able to relate one material to another to the material they have read so that they can indirectly hone students' reading skills. Students' reading ability can be honed in various ways, one of which is through the strategies applied in the reciprocal teaching approach [15]. Important ideas in a text can be predicted by students by involving the knowledge that has been obtained previously to be combined with information obtained during learning. Therefore, mathematical connection skills are also very necessary to be able to connect existing material with new material or to be studied in reciprocal teaching-learning. Reciprocal teaching had the greatest impact on students' mathematical communication abilities and self-regulated learning among school clusters [16]. This is in line with the research found by [17], students who learn utilizing the reciprocal teaching approach achieve and develop their mathematical understanding and communication ability more than students who learn regularly. In mathematics, a reciprocal teaching strategy can help students develop exceptional critical thinking, reasoning, and comprehension skills [18]. The use of a reciprocal teaching-learning approach improved the ability of junior high school students to think mathematically creatively [19].

Judging from the characteristics of the scientific approach and the reciprocal teaching approach, both have similarities. According to [20], [21], the scientific approach has the following characteristics: (1) student-centered; (2) involves science process skills in constructing concepts, laws, or principles; (3) involve potential cognitive processes in developing intelligence, especially students' higher-order thinking skills; (4) can develop students' character; (5) students acquire knowledge through steps: observing, questioning, collaborating, experimenting, associating, and presenting [22]. The characteristics of this scientific approach are in line with the characteristics of the reciprocal teaching approach. According to Palincsar and Brown in [23], reciprocal teaching has three distinct characteristics: (1) Explicit instruction and scaffolding are used by teachers, which is the foundation of a comprehension-fostering strategy; (2) Teachers employ the major reading skills of predicting, questioning, clarifying, and summarizing; (3) Finally, the approach encourages social interactions among students and between students and teachers, which helps students improve their cognitive abilities by allowing them to share their ideas, gain confidence, and learn from more experienced peers. In addition, learning objectives based on a scientific approach and reciprocal teaching have certain parallels due to the benefits of both approaches. According to [12], some common learning objectives include: (1) improving intellectual abilities, particularly students' higher-order thinking skills; (2) developing students' ability to solve problems systematically; (3) creating learning environments in which students believe that learning is a necessity and the teacher acts as a facilitator and motivates students to participate; (4) to achieve high and optimal learning outcomes by grouping students into small groups with heterogeneous group structures, thus providing opportunities for students to work together and teach each other with fellow students; (5) to train students in communicating ideas so that each member can communicate comfortably in conveying or asking questions to exchange learning experiences with one another; (6) to help pupils develop their personalities.

Furthermore, the comparison between the strategies found in the scientific approach and the reciprocal teaching approach has the same meaning, namely the observing strategy in the scientific approach has the same meaning in the predicting and clarifying strategies in the reciprocal teaching approach. Then the strategy of asking questions in the scientific approach has the same meaning as the questioning strategy in the reciprocal teaching approach, the strategy for gathering information in the scientific approach also has the same meaning as visualizing in the reciprocal teaching approach. Likewise, the reasoning strategy in the scientific approach has the same meaning as the connecting and calculating strategy in the reciprocal teaching approach, and the communication strategy also has the same meaning as the summarizing and giving feedback strategy in the reciprocal teaching approach. Based on the characteristics, learning objectives, and strategies of the scientific approach and reciprocal teaching approach that has been described, it is difficult to side with which one is better, so it is necessary to conduct a comparative research test on the two approaches in the experimental class.

Learning that is interesting, student-centered, and following the maturity level of students can improve mathematical connection skills in low-group students. However, the opposite can happen for students in the high group, because in this group students can more quickly understand the mathematical material being studied because of their intelligence, even without using various interesting and student-centered approaches. The existence of this difference is thought to be related to the different students' prior mathematical knowledge (PAM), so it is necessary to include the students' PAM to see whether the students' PAM affects increasing students' mathematical connection abilities. This is supported by the results of research conducted by [24], which found that there was a significant relationship between PAM and logical thinking skills, and there was a significant difference in students' logical thinking abilities in terms of PAM. It was also found by Lestari that there was an effect of early mathematics ability on mathematics learning outcomes [25]. In addition, [26] also found that there were differences in the results of increasing students' mathematical creative thinking skills who received learning using the Mathematical Habits of Mind strategy with students who received conventional learning based on PAM.

Through this research, it is expected to create learning that can encourage an increase in students' mathematical connection abilities, so the purpose of this study is to examine and describe: (1) Increasing the mathematical connection abilities of students who receive learning with a scientific approach compared to students who receive learning using a reciprocal teaching approach based on PAM students (high and low); (2) The effect of the interaction between learning (scientific and reciprocal teaching) and students' PAM (high and low) on increasing students' mathematical connection skills.

II. METHODS

This study used all research subjects in each sample class to be given treatment and subjects were not taken randomly. Researchers accept the state of the subject as it is to avoid chaos in the existing learning schedule at school [27]. This study used two experimental classes. The first experimental class received treatment using a scientific approach, while the second experimental class received treatment using a reciprocal teaching approach. This study also involved students' PAM, where PAM was determined before being given treatment. The PAM grouping was determined based on the average of each experimental class which consisted of a high PAM group and a low PAM group. Both experimental classes were given the same pre-test and post-test, namely the mathematical connection ability test. The following is a table of research design patterns.

TABLE 1. Table of Research Design Patterns

		Class	**PAM**	***Pre Test***	**Treatment**	***Post Test***
Subject	***Non-Random* (NR)**	Experiment 1	High	Mathematical connection ability test	Scientific	Mathematical connection ability test
			Low			
		Experiment 2	High		*Reciprocal Teaching*	
			Low			

Based on the research design pattern table, the design used in this study was adapted from the research design according to Cohen et al. [28], namely Pretest Posttest Two Treatment Design. The design used can be described as follows:

O_1	X_1	O_2
O_1	X_2	O_2

Fig 1. Pretest Posttest Two Treatment Design

Description: $O_1 = O_2$; O_1 = *Pre Test;* O_2 = *Post Test;* X_1= Giving treatment with a scientific approach; X_2 = Giving treatment with reciprocal teaching approach.

The research variables in this study can be described as follows: (1) The dependent variable, namely the ability of mathematical connections; (2) independent variables, namely the scientific approach and reciprocal teaching approach; (3) Predictors, namely PAM students. The relationship between the dependent variable, independent variable, and predictor can be seen in the following Weiner Table:

TABLE 2. Weiner's table on the relationship between independent, dependent, and predictor variables

Measured ability		**Mathematical Connection (Km)**	
Approach		Scientific (A)	*Reciprocal Teaching* (B)
PAM	High (T)	KmTA	KmTB
	Low (R)	KmRA	KmRB

Description: KmTA = The mathematical connection ability of high the PAM group with a scientific approach; KmTB = The mathematical connection ability of high the PAM group with a reciprocal teaching approach; KmRA = The mathematical connection ability of low the PAM group with a scientific approach; KmRB = The mathematical connection ability of low the PAM group with a reciprocal teaching approach.

The research subjects in this study were all grade VIII junior high school students who had implemented the 2013 Curriculum in the city of Bandung because the scientific approach had been applied in the 2013 Curriculum. Initial information in the selection of samples was carried out based on the considerations of teachers in the field of mathematics studies to obtain two experimental classes with PAM which same. By looking at the condition of the research sample like this, so that the determination of the sample at the school that is the subject of the study is carried out using the purposive sampling technique [29]. The consideration in selecting the research sample for students of class VIII SMP as the research sample is based on Piaget's opinion [30], that class VIII students enter the age of 11 and 12 years and over enter the formal operation stage. At this stage a person can think logically, think formally theoretically, his logic begins to develop, and can provide arguments according to what he thinks and feels so that it is suitable for measuring students' mathematical connection abilities. The selection of students for the two experimental classes will not be based on true randomness, only based on the existing classes. This is because the researcher can't form a new class, so the researcher takes the smallest sample unit, namely the class. The research subjects in the class that received the treatment of the scientific approach were 32 people, while in the class that received the treatment with the reciprocal teaching approach as many as 30 people. The reason for choosing the number of research subjects was with the consideration that the minimum number of research subjects for each class was 30 people [31].

The teaching materials in this study were teaching materials used in learning mathematics with a scientific approach based on the 2013 Curriculum for the experimental class 1 and learning with the reciprocal teaching approach for the experimental class 2. The teaching materials were developed according to the strategies contained in each approach that included Circle material, which is one of the materials that must be taught in SMP/MTs mathematics learning [32]. Mathematical ability tests are structured in the form of connections and are tested on students at different times. Mathematical connection ability test questions are arranged and developed based on indicators of the measured ability. Before testing the ability of the mathematical connection used, a trial was conducted to know whether the question had met the requirements of validity [33], reliability [34], level of difficulty (TK) [35], and discriminatory power (DP) [35]. This mathematical connection ability test question is tested on students in the same school as the school that is the subject of research and these students must have received the Circle material. This validity test uses the opinions of five experts, namely mathematicians, learning experts, evaluation experts, mathematics study teachers, and Indonesian language teachers [34]. Furthermore, it was tested on a limited basis to five students outside the research sample who had received the material being tested. The results of content validity and advance validity were analyzed by the Q-Cochran test using SPSS Version 22.0 software for Windows, while the calculation of empirical validity, reliability, level of difficulty, and distinguishing power in this study used the Anates V.4 for Windows software. A summary of all the stages of the trial is presented in the following table.

TABLE 3. Recap of Analysis of Mathematical Connection Ability Test Items

Test Reliability = 0.65 (Medium)				
Question Points	Validity	TK	DP	Question Conclusion
1	Valid	Medium	Enough	Taken with revision
2	Valid	Medium	Well	Thrown away
3	Valid	Medium	Well	Taken with revision
4	Invalid	Medium	Bad	Thrown away
5	Valid	Medium	Enough	Taken with revision
6	Valid	Medium	Enough	Taken
7	Valid	Medium	Enough	Thrown away
8	Valid	Easy	Enough	Taken with revision
9	Valid	Medium	Well	Taken
10	Valid	Medium	Well	Taken with revision

The data obtained from this study is quantitative data obtained from students' answers to the pre-test and post-test in the form of mathematical connection ability scores. Data processing in this study using Microsoft Excel for Windows and SPSS Version 22.0 for Windows. Quantitative data analysis was carried out through the following stages: In the first stage, students were grouped based on Mathematical Preliminary Knowledge (PAM), namely high PAM and low PAM [36]. The second stage is to score students' answers on the pre-test and post-test of mathematical connection abilities according to the answer keys and scoring guidelines used, then calculate the value of the increase in ability that occurs with the normalized gain formula <g> Wilk [37]. The third stage is to present descriptive statistics of the mathematical connection ability pre-test score, post-test on the mathematical connection ability test, and normalized gain <g> using the Weiner model [38]. The fourth step is to test for normality on the <g> score using the Saphiro-Wilk statistical test [39]. The fifth step is to test the homogeneity of variance using Levene's test with SPSS Version 22.0 for Windows. Finally, the sixth stage is to test the hypothesis.

III. RESULTS AND DISCUSSIONS

Results

Data on increasing students' mathematical connections was processed using normalized gain data <g> mathematical connections. The average value of the normalized gain of mathematical connections of students who received scientific learning (experiment 1) was greater than students who received learning using a reciprocal teaching approach (experiment 2). Judging by the PAM criteria, both high PAM and low PAM have the same normalized gain average value, namely, the average normalized gain value of the experimental class 1 is greater than that of the experimental class 2. In addition, it can be seen that in the class with a scientific approach, the higher the student's PAM level, the greater the average normalized gain of mathematical connection ability, on the contrary in the class that received learning using the reciprocal teaching approach, it was seen that the average normalized gain of mathematical connection ability at high PAM was not higher than the average normalized gain of ability mathematical connection at low PAM.

The difference in the average value of the normalized gain has not been able to show a significant difference, it is necessary to test the average difference. Before performing the average difference test, a normality test and a homogeneity test of the variance of the two groups of data were carried out. The normalized gain data for low PAM and overall PAM is not normally distributed so that the normalized gain data for high PAM and low PAM is tested for the average difference using a non-parametric test, namely the Mann-Whitney test. In contrast to the overall PAM, the normalized gain data is normally distributed, so the homogeneity test can then be carried out using the Levene test. The result is that there is a difference in variance between classes that receive learning with a scientific approach and classes that receive learning using a reciprocal teaching approach (the variance is not homogeneous), so to test the difference in the average normalized gain on high PAM and overall, a non-parametric test is carried out, namely t' test. The results of the average difference test for the complete normalized gain data can be seen in TABLE 4 below.

TABLE 4. Test Results Differences in Average Data Gain Normalized Mathematical Connection Ability Based on PAM

Student PAM	Average ($\bar{x}$)		**Statistic test**	**Sig.**	**Conclusion H_0**
	Scientific	Reciprocal Teaching			
Tall	0.7132	Mann-Whitney test	Uji *Mann-Whitney*	Reject H0	Tolak H_0
Low	0.6931	Mann-Whitney test	Uji *Mann-Whitney*	Reject H0	Tolak H_0
Total	0.6991	t' test	Uji t’	Reject H0	Tolak H_0

H_0: There is no difference in the average normalized gain score for mathematical connection abilities

Based on TABLE 4 above, both high PAM and low PAM, and overall PAM have a significance value < = 0.05, this means that H_0 is rejected, meaning that there is a difference in the normalized gain of the mathematical connection between the class that received learning with a scientific approach and the class that received learning with a reciprocal teaching approach. Looking in more detail at the average value of each PAM, both high PAM and low PAM as well as PAM as a whole, it can be seen that the average increase in classes that receive learning with a scientific approach is greater than in classes that receive learning with a reciprocal teaching approach. This shows that the increase in the mathematical connection of the class that received learning with a scientific approach was better than the class that received learning with the reciprocal teaching approach, both at high PAM and low PAM as well as overall PAM. Therefore, it was concluded that there were differences in the improvement of mathematical connection skills between students who received learning using a scientific approach and students who received learning using a reciprocal teaching approach based on students' PAM (high and low).

The improvement of students' mathematical connection skills in this study involved the interaction of two factors, namely the learning factor applied to each experimental class and the student PAM grouping factor. Testing the effect of interaction using a two-way ANOVA test. As a prerequisite for the analysis, a normality test is carried out first with the results of the normalized gain data on the mathematical connection is not normally distributed, so that the normalized gain data for the mathematical connection does not meet the assumptions of the parametric test. However, because there is no suitable non-parametric test as an alternative to the two-way ANOVA test with independent samples as in the case of this study so that data analysis on normalized gain can only be done descriptively analysis [40] of Fig. 2 following.

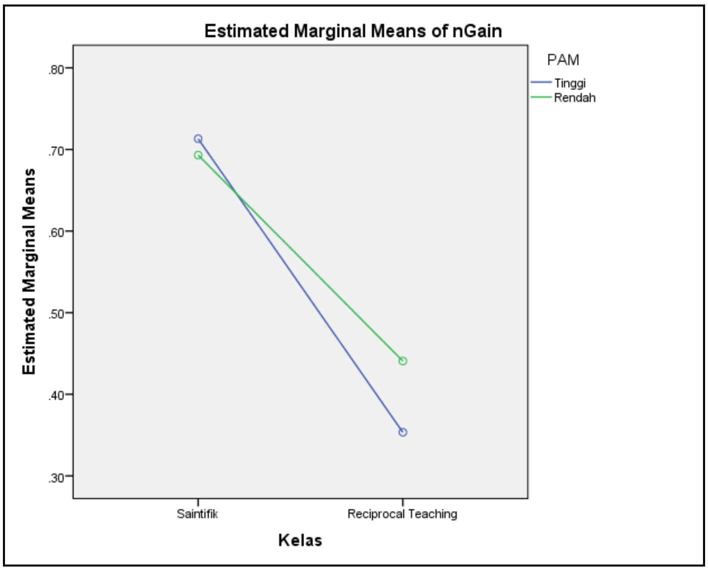

Fig 2. Graph of Interaction between Classroom Learning and PAM on Increasing Students' Mathematical Connection Ability

Based on Fig. 2 it can be seen that in general the increase in mathematical connection abilities of students who receive scientific learning is significantly higher than students who receive learning using a reciprocal teaching approach. In experimental class 1, the highest increase in mathematical connection ability was achieved by the high PAM group of students, and the lowest mathematical connection ability was achieved by the low PAM group. This illustrates that in the class that received learning with a scientific approach to the Circle material, there was no change in the order of increasing mathematical connection abilities. The increase in mathematical connection of high PAM students remains more dominant than low PAM students. In experimental class 2, the highest increase in mathematical connection ability was achieved by the low PAM student group, and the lowest increase in mathematical connection ability was achieved by the high PAM student group. This illustrates that in the class that received learning by reciprocal teaching for the Circle material, there has been a change in the order of increasing mathematical connection abilities. The increase in mathematical connection of students who have low PAM can exceed students who have high PAM. So it can be concluded that there is an interaction between the learning class factors used and the students' PAM grouping factors. The interaction is indicated by the intersection of the marginal mean line between high PAM students and low PAM students in each class that receives learning using a scientific approach and classes that receive learning using a reciprocal teaching approach. However, this interaction did not significantly affect the improvement of students' mathematical connection skills, which means that there was no joint influence between learning factors and PAM grouping factors on increasing students' mathematical connection abilities. This happens because the change in the sequence of increasing mathematical connection skills in PAM students only occurs in classes that receive learning by reciprocal teaching, while in the scientific class there is no change. This means that the learning applied to each experimental class can be applied and applied as a whole to all students, both students belonging to the high PAM and low PAM groups to improve students' mathematical connection skills.

Discussions

The results of the study on increasing students' mathematical connection abilities showed that there were differences in the improvement of mathematical connections between students who received learning with a scientific approach and students who received learning with a reciprocal teaching approach, both at high PAM, low PAM, and overall PAM. This result is following the hypothesis proposed earlier, namely "there are differences in the improvement of mathematical connection skills between students who receive learning using a scientific approach and students who receive learning using a reciprocal teaching approach based on students' PAM (high and low)". In PAM as a whole, the average increase in mathematical connection skills in students who received learning with a scientific approach reached 0.6991 with moderate criteria. Meanwhile, the average increase in mathematical connections in students who received learning using a reciprocal teaching approach reached 0.3998 with moderate criteria. At high PAM, the average increase in mathematical connection skills in students who receive learning with a scientific approach reaches 0.7132 with high criteria. Meanwhile, the increase in mathematical connections in students who received learning with a reciprocal teaching approach reached 0.3534 with moderate criteria. At low PAM, the average increase in mathematical connection skills in students who receive learning with a scientific approach reaches 0.6931 with moderate criteria. Meanwhile, the average increase in mathematical connections in students who received learning using a reciprocal teaching approach reached 0.4607 with moderate criteria.

Based on the description of the quality of increasing mathematical connection, it is clear that the average increase in mathematical connection ability in the class with the scientific approach is higher than the class with the reciprocal teaching approach. This can be seen in the average increase in high PAM in classes with a high-quality scientific approach, while in classes with a reciprocal teaching approach it is only of moderate quality. In addition, in the description of the distribution of the quality of student improvement described above, it can be seen that the class with a scientific approach has a relatively high quality of improving mathematical understanding with high-quality N-Gain and moderate N-Gain and no N-gain with low quality. So it can be concluded that learning with a scientific approach can support and facilitate the improvement of students' mathematical connection abilities compared to learning with a reciprocal teaching approach, both for the high PAM group and the low PAM group as well as the PAM group as a whole. The findings based on the test are also supported by the results of observations of student responses. The results of these observations show a tendency that the improvement of students' mathematical connection skills who receive learning with a scientific approach is better than students who receive learning using a reciprocal teaching approach. These results also explain that the increase in mathematical connection does not appear suddenly at the time of the test. The results showed that in the learning process at each meeting, activities related to the mathematical connection ability of students who received learning with a scientific approach were not better than students who received learning using a reciprocal teaching approach because at the first meeting students were still awkward and unfamiliar with the learning. However, at the next meeting, students were able to adapt and follow the learning well. The average percentage of student activity who received learning with a scientific approach was superior to learning with a reciprocal teaching approach. So this is quite supportive that the learning process with a scientific approach contributes to improving students' mathematical connection abilities.

The next discussion regarding the interaction between learning classes and PAM grouping shows that there is an interaction between the learning class factors used and the students' PAM grouping factors. The interaction is indicated by the intersection of the marginal mean line between high PAM students and low PAM students in each class that receives learning using a scientific approach and classes that receive learning using a reciprocal teaching approach. However, this interaction did not significantly affect the improvement of students' mathematical connection skills, which means that there was no joint influence between learning factors and PAM grouping factors on increasing students' mathematical connection abilities. This happens because the change in the sequence of increasing mathematical connection skills in PAM students only occurs in classes that receive learning by reciprocal teaching, while in the scientific class there is no change. This means that the learning applied to each experimental class can be applied and applied as a whole to all students, both students belonging to the high PAM and low PAM groups to improve students' mathematical connection skills.

In general, it can be concluded that students who receive learning using a scientific approach have been able to demonstrate better mathematical connection skills than students who have received learning using a reciprocal teaching approach, both in terms of achievement and improvement. Such conditions seem to have a relationship between indicators of mathematical connection ability and the strategies contained in each approach, both in the scientific approach and in the reciprocal teaching approach. All indicators of mathematical connection ability in this study were greatly facilitated by the Reasoning strategy in the scientific approach because in this strategy students were accustomed to processing information that had been collected, both limited to the results of collecting/experimenting activities, as well as the results of observing activities and information gathering activities. Students also relate the knowledge previously acquired with the knowledge acquired now to improve their mathematical connection skills. The reasoning activity in this strategy is carried out to find the relationship between a concept/material with other concepts/materials [41]. During the transfer of specific events to the brain, the experience is stored about other events. Experiences that have been stored in the brain's memory relate and interact with previous experiences that are already available. This is in line with Bruner's view [42] which states that learning is an active process in which learners construct new ideas or concepts based on previous and present knowledge. Learners select and transform information, construct hypotheses, and make decisions by reference and based on their internal cognitive structures. While in the reciprocal teaching approach, students are facilitated in two strategies, namely Connecting and Calculating. In the Connecting strategy, students recall the same material and are still related to the material/problem at hand, and in the Calculating strategy, students use a problem-solving strategy and present it. However, based on field observations, students with a reciprocal teaching approach are still not familiar with these two strategies, so the results obtained are also less than optimal. This is because the learning process takes place during the day, so it affects the thinking power and concentration of students, wherein this strategy students have to think hard. While students with a scientific approach are not like that, learning takes place in the morning to provide maximum results.

Seeing the advantages of learning with a scientific approach compared to learning with a reciprocal teaching approach in facilitating mathematical connection abilities, it is very possible that learning with a scientific approach is better than learning with reciprocal teaching in improving mathematical connection abilities. However, to achieve the desired mathematical connection ability, the achievement is still not optimal. This shows that cultivating high-level mathematical thinking processes in mathematics learning is not an easy job. However, it is undeniable that students who receive learning with a scientific approach can show better improvements compared to students who receive learning using a reciprocal teaching approach.

IV. Conclusion

Based on the results of research and discussion, it can be concluded that there are differences in the improvement of mathematical connection skills between students who receive learning using a scientific approach and students who receive learning using a reciprocal teaching approach based on students' PAM (high and low). Looking in more detail at the average value of each PAM, both high PAM and low PAM as well as PAM as a whole, it can be seen that the average increase in classes that receive learning with a scientific approach is greater than in classes that receive learning with a reciprocal teaching approach. In addition, there is no interaction effect between learning (scientific and reciprocal teaching) and students' PAM (high and low) on increasing students' mathematical connection abilities. This means that there is no joint influence between learning factors and PAM grouping factors on increasing students' mathematical connection abilities. So that the learning applied to each experimental class can be applied and applied as a whole to all students, both students belonging to the high PAM and low PAM groups to improve students' mathematical connection skills.

Acknowledgment

This research could not be carried out without the help and support of various parties. The author would like to thank the lecturers who have provided some motivation and suggestions for the perfection of this article and also the author would like to thank the big family of SMP Negeri 5 Bandung who has helped a lot in the implementation of this research.

References

[1] C. Khairunnisak, M. Hasbi, A. Mustika, and E. Elizar, “Students’ mathematical connection ability in the learning employing contextual teaching and learning,” *J. Phys. Conf. Ser.*, vol. 1460, no. 1, p. 012028, Feb. 2020, DOI: 10.1088/1742-6596/1460/1/012028.

[2] N. Diana, D. Suryadi, and J. A. Dahlan, “Analysis of students’ mathematical connection abilities in solving problem of circle material: Transposition study,” *J. Educ. Gift. Young Sci.*, vol. 8, no. 2, pp. 829–842, 2020, doi: 10.17478/JEGYS.689673.

[3] A. Baki and O. Birgin, "World Conference on Educational Sciences 2009 Conceptions of high school students about mathematical connections to the real-life," no. December 2015, 2009, DOI: 10.1016/j.sbspro.2009.01.247.

[4] S. Haji, M. I. Abdullah, and S. Maizora, "Developing Students ' Ability of Mathematical Connection through Using Outdoor," vol. 6, no. 1, pp. 11–20, 2017, DOI: 10.22460/infinity.v6i1.234.

[5] J. A. Eli, M. J. Mohr-Schroeder, and C. W. Lee, “Mathematical Connections and Their Relationship to Mathematics Knowledge for Teaching Geometry: Mathematical Connections and MKT Geometry,” *Sch. Sci. Math.*, vol. 113, no. 3, pp. 120–134, Mar. 2013, DOI: 10.1111/ssm.12009.

[6] J. A. Eli, M. J. Mohr-, and C. W. Lee, "Exploring mathematical connections of prospective middle-grades teachers through card-sorting tasks," vol. 23, no. 3, pp. 297–319, 2011, DOI: 10.1007/s13394-011-0017-0.

[7] H. Hendriana, U. R. Slamet, and U. Sumarmo, “Mathematical Connection Ability and Self-Confidence (An experiment on Junior High School students through,” *Int. J. Educ.*, vol. 8, no. 1, p. 11, 2014.

[8] D. N. Sudjito, N. R. Keliat, and S. P. Hastuti, “Integrated Science Learning Using Scientific Approach in Junior High Schools in Semarang Regency,” *Indones. J. Sci. Educ.*, vol. 2, no. 1, p. 69, Apr. 2018, DOI: 10.31002/ijose.v2i1.583.

[9] S. Zahara, A. G. Haji, and M. Syukri, “Improving the Concept Understanding and Scientific Attitudes through the Implementation of Scientific Approach,” *Tadris J. Kegur. Dan Ilmu Tarb.*, vol. 3, no. 1, p. 55, Jun. 2018, DOI: 10.24042/tadris.v3i1.2513.

[10] W. Jannah and I. Dewata, “The Correlation Of A Scientific Approach Using The Probing Prompting Technique And A Problem-Based Learning Model On Learning Outcomes On Reaction Rate Material,” vol. 27, no. 2, p. 15, 2021.

[11] M. Havid and Yulkifli, "Validity of Student Worksheet Inquiry Based Learning Model with Scientific Approach Integrated Creative Thinking Skills for Grade XI Physics Learning on 21st Century," vol. 27, no. 1, p. 8, 2021, DOI: 10.52155.

[12] A. Machin, “Implementasi Pendekatan Saintifik, Penanaman Karakter dan Konservasi pada Pembelajaran Materi Pertumbuhan,” p. 8, 2014.

[13] I. S. Nugraha and D. Suherdi, “Scientific Approach: An English Learning-Teaching (Elt) Approach in The 2013 Curriculum,” p. 16, 2013.

[14] I. Ghozali, “Pendekatan Scientific Learning dalam Meningkatkan Prestasi Belajar Siswa,” vol. 04, no. 01, p. 13, 2017.

[15] R. McAllum, “Reciprocal Teaching: Critical Reflection on Practice,” vol. 15, no. 1, p. 10, 2014.

[16] A. Qohar and U. Sumarmo, “Improving Mathematical Communication Ability and Self Regulation Learning Of Yunior High Students by Using Reciprocal Teaching,” *J. Math. Educ.*, vol. 4, no. 1, pp. 59–74, Jan. 2013, doi: 10.22342/jme.4.1.562.59-74.

[17] I. Yuniar, E. E. Rohaeti, and R. B. A. Soekisno, “Improving Understanding and Mathematical Communication Level and Study Learning with Reciprocal Teaching Approach,” *JIML J. Innov. Math. Learn.*, vol. 1, no. 2, p. 136, Jul. 2018, DOI: 10.22460/jiml.v1i2.p136-142.

[18] S. Aslam, A. Saleem, A. U. Hali, and B. Zhang, “Promoting Sustainable Development in School Classrooms: Using Reciprocal Teaching in Mathematics Education,” *TEM J.*, pp. 392–400, Feb. 2021, DOI: 10.18421/TEM101-49.

[19] Rasmuin, E. Jais, and Sardin, “The Effect of Mathematics Learning With using Reciprocal Teaching Model on Mathematics Creative Thinking Ability,” *J. Phys. Conf. Ser.*, vol. 1477, no. 4, p. 042041, Mar. 2020, DOI: 10.1088/1742-6596/1477/4/042041.

[20] Hosnan, *Pendekatan Saintifik dan Kontekstual dalam Pembelajaran Abad 21 - Kunci Sukses Implementasi Kurikulum 2013*. Bogor: Ghalia Indonesia, 2014.

[21] Y. Febriana, “Penerapan Pendekatan Saintifik untuk Meningkatkan Keterampilan Proses Sains Di Kelas IV SD,” vol. 1, no. 1, p. 14, 2016.

[22] H. D. Putra, T. Herman, and U. Sumarmo, “The Impact of Scientific Approach and What-If-Not Strategy Utilization towards Student’s Mathematical Problem Posing Ability,” *Int. J. Instr.*, vol. 13, no. 1, pp. 669–684, Jan. 2020, doi: 10.29333/iji.2020.13143a.

[23] M. Y. A. AlSaraireh and K. M. N. K. Hamid, “The Effect of the Reciprocal Teaching Model on Developing Jordanian Students’ Reading Comprehension at Mutah University,” *Int. J. Linguist.*, vol. 8, no. 6, p. 69, Dec. 2016, doi: 10.5296/ijl.v8i6.10448.

[24] A. S. Pamungkas, Y. Setiani, and H. Pujiastuti, “Peranan Pengetahuan Awal dan Self Esteem Matematis Terhadap Kemampuan Berpikir Logis Mahasiswa,” *Kreano J. Mat. Kreat.-Inov.*, vol. 8, no. 1, pp. 61–68, Jun. 2017, doi: 10.15294/kreano.v8i1.7866.

[25] W. Lestari, “Pengaruh Kemampuan Awal Matematika dan Motivasi Belajar terhadap Hasil Belajar Matematika,” *J. Anal.*, vol. 3, no. 1, p. 76, Jun. 2017, doi: 10.15575/ja.v3i1.1499.

[26] I. N. Aini, “Analisis Kemampuan Berpikir Kreatif Matematis Siswa Berdasarkan Pengetahuan Awal Matematis,” *Prima J. Pendidik. Mat.*, vol. 2, no. 1, p. 57, Jan. 2018, doi: 10.31000/prima.v2i1.423.

[27] H. E. T. Ruseffendi, *Dasar-dasar penelitian pendidikan dan bidang noneksakta lainnya*. Bandung: Tarsito, 2005.

[28] L. Cohen, L. Manion, and K. Morrison, *Research methods in education*, 6th ed. London ; New York: Routledge, 2007.

[29] Sugiyono, “Statistik untuk penelitian,” Bandung: Alfabeta, 2007.

[30] P. Suparno, “Teori perkembangan kognitif Jean Piaget,” Yogyakarta: Kanisius, 2001.

[31] Darhim, “Slide presentation: Materi perkuliahan penelitian kuantitatif,” Bandung, 2014.

[32] Kemdiknas, “Permendiknas RI No. 23 tahun 2006 tentang standar kompetensi lulusan untuk satuan pendidikan dasar dan menengah.” Kementrian Pendidikan Nasional, 2006.

[33] S. Arikunto, *Prosedur penelitian suatu pendekatan praktik*. Jakarta: Rineka Cipta, 2010.

[34] Suherman, *Evaluasi pembelajaran matematika*. Bandung: Universitas Pendidikan Indonesia, 2003.

[35] Safari, *Penulisan butir soal*. Jakarta: Asosiasi Pengawas Sekolah Indonesia., 2005.

[36] E. Khaerunnisa, “Peningkatan kemampuan pemecahan masalah dan adversity quotient matematis siswa MTS melalui pendekatan pembelajaran eksploratif,” Thesis, Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Bandung, 2013.

[37] R. R. Hake, *Analyzing change/gain scores*. California: Dept. of Physics, Indiana University., 1999.

[38] A. Mudrikah, “Pembelajaran Berbasis Masalah Berbantuan Komputer untuk Meningkatkan Kemampuan Komunikasi, Pemecahan Masalah, dan Disposisi Matematik Siswa Sekolah Menengah Atas,” Thesis, Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Bandung, 2012.

[39] N. A. Ahad, T. S. Yin, C. R. Yaacob, and A. R. Othman, “Sensitivity of normality test to non-normal data (kepekaan ujian kenormalan terhadap data tidak normal),” *Sains Malaysiana*, vol. 40, no. 6, pp. 637–641, 2011.

[40] B. A. P. Martadiputra, “Meningkatkan kemampuan berpikir statistis mahasiswa S1 pendidikan matematika melalui pembelajaran MEAs yang dimodifikasi,” Dissertation, Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Bandung, 2012.

[41] Kemdikbud, “Materi pelatihan implementasi kurikulum 2013 tahun 2014.” Kementrian Pendidikan dan Kebudayaan, 2014.

[42] S. G. Wardoyo, *Pembelajaran Konstruktivisme*. Bandung: Alfabeta, 2013.