Proceedings of International Conference on Teacher Profession Education
Yogyakarta, 29 July 2023

ISSN: 3025-020X

Improving Student's Mathematical Connection Ability Through Project Based Learning

Lulu Kholifah[1*], Zainnur Wijayanto[2,] Faridha Khuril Maknun[3]

[1,2]*Universitas Sarjanawiyata Tamansiswa, Indonesia*

[3]*SD Negeri Tegalpanggung, Indonesia*

**Corresponding Author e-mail: khoolifah416@gmail.com*

1. Abstract

The purpose of this study was to improve the mathematical connection of statistics material through Project Based Learning with the Teaching at the Right Level (TaRL) approach in 4th grade students totaling 18 children. This research method is a classroom action research model of Kemmis and Mc. Taggart model. Each cycle consists of planning, action, observation, and reflection. Data collection techniques used observation, tests, documentation, and interviews. The performance indicator set is that at the end of the cycle 75% of the number of grade 4 students have mathematical connection skills in the good category with a minimum score of 70. The conclusion obtained from the research is that the Project Based Learning (PjBL) model can improve mathematical connection skills in grade 4 students. This is shown through the results of initial observations, students have mathematical connection skills with an average score of 61 in the sufficient category. After the implementation of cycle 1 action, the average score of mathematical connection ability increased to 68 although it was still in the sufficient category. In cycle 2, the math connection ability score again increased to 75 and was included in the good category.

Keywords: *project-based learning, tarl approach, mathematical connection*

2. Introduction

Mathematics as a structured and systematic science serves as the basis for the development of knowledge and technology. Mathematics helps develop a rational thinking

ISSN: 3025-020X

process based on facts, understanding reality that is useful for solving problems in various contexts. Therefore, it is important that mathematics is taught at every level of education from elementary school to college. This is also stated in Permendiknas No 22 Tahun 2006 Tentang Standar Isi which states that mathematics learning needs to be given to students starting from the elementary school level to equip students with the ability to think logically, analytically, systematically, critically, creatively, and collaboratively.

Mathematics provides great benefits in everyday life. The mathematics learning process should be able to facilitate students to explore and emphasize meaningfulness so that the knowledge gained can be applied in everyday life. The National Council of Teachers of Mathematics (2000) argues that the central goal of mathematics education should be able to develop skills, one of which is mathematical connection skills. When students can find the connection between all the different components in mathematics, then students can see that mathematics is an integrated unit. According to research findings, students will need to be able to make mathematical connections in order to solve problems, particularly those that call for a connection between mathematical concepts and other concepts from other disciplines or from daily life (Rohendi & Dulpaja, 2013). Students who master mathematical concepts may not necessarily have strong mathematical connections, but mathematical connection skills are still crucial. In one study, it was discovered that although students could frequently recall mathematical ideas connected to actual issues, few of them could articulate the rationale behind the concepts' use (Bergeson, 2000). Therefore, one component of mathematical skills that pupils need to develop is the capacity for making mathematical connections.

Facts in schools show that mathematics learning that leads to the improvement of mathematical connection skills is relatively low. Students must become competent in understanding the connections between mathematics and other areas of knowledge as well as between mathematics and their life experiences, and competent in applying the mathematical knowledge needed to maximize the productivity of these connections (Sawyer, 2008). The survey conducted by Trends in International Mathematics and Science Study (TIMSS) shows that mathematics learning in Indonesia is limited to emphasizing basic skills (Prastyo, 2020: 115). From the problem of low mathematical connections above, students are not able to make their own mathematical connections. Making connections is fundamental in mathematics education and has a significant impact on learning strategies. One of the causes of students' low mathematical connection skills lies in the learning modeling factor or the use of learning methods that contribute to low connection skills. This is reinforced by Sawyer's (2008) statement that examples of students in these teachers' classrooms demonstrating the ability to connect mathematical knowledge with other types of disciplinary knowledge and with real-world situations are evidence of the efficacy of their practice.

According to Wena (2009: 114), Project Based Learning is a learning approach that allows teachers to manage learning in the classroom by including project work. Mathematics learning in class that includes project work necessitates students working in the classroom, outside of the classroom, or as homework assignments. The teacher usually provides math tasks in the form of questions, summaries, or experiments. The assignment is thought to give learning opportunities and boost comprehension among students.

School-based learning that is extremely controlled (children sit still a lot) and forced does not allow youngsters to explore and assimilate information in their thoughts (Lusardi, 2012; Tout, 2020). The child will feel uncomfortable learning if the teacher does not pay attention and consider instruction that is appropriate for the child's age,

psychological development, and individual needs. This condition can lead to youngsters being unable to accept learning and experiencing setbacks, which can lead to a loss of self-confidence (Purpura, Hume, Sims, & Lonigan, 2011; Wulandari, 2012). These children will fall further behind if teachers and parents do not pay attention to their learning style and speed.

Learning will be meaningful based on the child's aptitude or level (teaching at the appropriate level). Furthermore, learning based on ability will increase children's learning motivation, allowing them to establish themselves as actual learners (learners). A person who is motivated to learn will be eager to tackle obstacles, think creatively, and seek solutions (Banerji & Chavan, 2016). The TaRL method to project-based learning is a collaborative effort to assist students in developing the necessary connective mathematic skills. As a result, teachers, principals, school administrators, education offices, and other stakeholders must be acquainted with the TaRL Approach. The use of project-based learning in assessment, grouping, and learning through the TaRL approach allows teachers to see students as entire people. Teaching children with varying capacities is a fascinating challenge. We need enough understanding to give learning services to all children based on their ability.

Based on the results of observations made, it appears that the ability of students to connect ideas between mathematics is still lacking, one of which is in statistics material, especially on bar chart material. Often students have difficulty understanding and explaining information presented in the form of diagrams. In addition, students also have difficulty converting and presenting data findings into diagrams so that they are easier to understand. Learners also lack the benefits of what is obtained so that it tends to be memorization and mastery of concepts only. The understanding of mathematical concepts obtained by students cannot be used to solve problems that are relevant to everyday life. This has an impact on the attitude of students who tend to be more passive when participating in learning, the absence of self-confidence, and others. In addition,

students also have different initial abilities that have not been facilitated by their learning needs and have an impact on their understanding of basic mathematics concepts. Learners who do not understand basic concepts will result in low mathematical connections. Through learning using the Project Based Learning model with the Teaching at the Right Level approach, it can bridge the differences in the initial abilities of students so that it will improve their mathematical connection skills.

3. Methods

3.1. Participants and context

The type of research used is collaborative classroom action research that focuses on improving mathematical connection skills through the application of the Project Based Learning model using the Teaching at the Right Level (TaRL) approach. The subjects in this study were 4th grade students totaling 18 children. The activities in this study were carried out through cycles. The next cycle is determined by the previous cycle and the cycle will continue until the expected results are obtained. The research procedure consists of two cycles. Each cycle consists of four stages of activities, namely planning, action, observation/evaluation, and reflection (Arikunto, 2021).

The project-based learning model in this study refers to the syntax developed by Muskania and Wilujeng (2017) which consists of 6 phases, namely (1) asking questions derived from surrounding phenomena, (2) designing stages in project completion, (3) preparing a project implementation schedule, (4) collecting, analyzing, and interpreting data using mathematics, information, computer technology, and computational thinking, (5) preparing project reports and presentations, 6) evaluating project processes and results.

Mathematical connection skills refer to the opinions of several experts, namely Bruner and Kenney (in Bell, 1978); NCTM (2000); NCTM (1989); Coxford (1975); Micovich & Monroe (1994); Sumarno (2004); Shafer & Foster (1997) so that 4 aspects of indicators

are obtained, among others: (1) integrating information, (2) creating a connection within and between mathematics, (3) Using a math equation or formula, (4) solving non-routine problems.

3.2. Material

Data collection using test techniques. The test used is a question about simple statistical material in the form of a description of 6 items. Each item gets a maximum score of 4. The preparation of questions is based on indicators of assessment of mathematical connection skills that have been determined based on expert opinion references. The test was given to students during the second meeting of each cycle.

3.3. Data Collection and analysis

The test data that shows the ability of mathematical connections is then analyzed using numbers so that it is called quantitative descriptive. Quantitative analysis is used to compare the results of students during the cycle so that it can be seen if there are changes. The criteria for the success of the study is if 75% of the number of grade 4 students have mathematical connection skills in the good category with a minimum score of 70. The test results were collected and calculated the number of scores of each student then distributed in the score range table. After the score of each learner is known, the data is used to determine the class average. Through this data, the percentage of success rate can also be known in achieving predetermined indicators. The category of classification of math connection ability scores in this study refers to the opinion (Parwati et al., 2020) as follows:

Table 1. Category of Math Connection Ability Score

Criteria	Category
85 – 100	Very Good
70 - 84	Good
55 – 69	Enough
40 – 54	Less
0 – 39	Very Less

3.4. Ethical Considerations

This study aimed to improve the mathematical connection ability of grade 4 students who were observed after the cycle 1 action was completed. Evaluation and reflection of each cycle were used as a consideration for determining actions in the next cycle.

3.5. Limitations to the Study

This research was conducted in conjunction with the Assessment of Regional Education Standardization (ASPD) agenda for Grade 6 students so the school was closed. In addition, Grade 4 students were also preparing for the even semester final exam. This resulted in a limited time allocation for the research. The condition of learners who were bored because they were given the same action continuously with a disproportionate duration of time had an impact on the results of the study.

4. Results and Discussion

Before carrying out the treatment of the subject, a test was first carried out so that the initial ability of the students could be known. This test is also used as one of the considerations for forming study groups.

Table 2. Recapitulation of Initial Ability Test Results
Math Connection on Initial Observation

Criteria	Score Range	Frequeny	Percentage	Average
Completed	70 - 100	6	34%	**61**
Not Completed	< 70	12	66%	
	Total	**18**		
	Highest Score	**88**		
	Lowest Score	**25**		

Based on the test results, the average class score is still below the KKM for math content. The average value only reached 61 while the KKM was 70. Students who managed to get the KKM score were only 6 people with a percentage of 34% of the total number of students.

Cycle 1

The results of data analysis of students' mathematical connection skills in cycle 1 are presented in the following table.

Table 3. Distribution of Math Connection Ability Score in Cycle 1

No	Criteria	Category	Frequency	Percentage	Average
1	85 – 100	Very Good	2	11%	**68**
2	70 - 84	Good	7	39%	
3	55 – 69	Enough	6	33%	
4	40 – 54	Less	3	17%	
5	0 – 39	Very Less	0	0%	
Total			**18**	**100%**	

Table 3 shows that the value of mathematical connection ability is included in the sufficient category with an average value of 68. 9 students who still have not reached the KKM requirements so that classical completeness has only reached 50%. The results of the average value of students' mathematical connection skills per indicator in cycle I are presented in the following table.

Table 4. Mathematical Connection Ability for each Indicator in Cycle 1

No	Indicators of mathematical connections	Skor Rata-rata	Kategori
1	Integrating information	72	Baik
2	Creating a connection within and between mathematics	60	Cukup
3	Using a math equation or formula	60	Cukup
4	Solving uncommon problems	72	Baik

Table 4 shows that mathematical connection skills in the indicators of integrating information and solving non-routine problems are in the good category. While the indicators of making connections within and between mathematics and determining formulas are still in the sufficient category.

Cycle 2

The results of data analysis of students' mathematical connection skills in cycle 2 are presented in the following table.

Table 5. Distribution of Math Connection Ability Score in Cycle 2

No	Criteria	Category	Frequency	Percentage	Average
1	85 – 100	Very Good	3	17%	**75**
2	70 – 84	Good	11	61%	
3	55 – 69	Enough	2	11%	
4	40 – 54	Less	2	11%	
5	0 – 39	Very Less	0	0%	
Total			**18**	**100%**	

Table 5 shows that the value of mathematical connection skills is included in the good category with an average value of 75. Learners who still have not reached the KKM requirements are 4 people with classical completeness reaching 78%. The results of the average value of mathematical connection ability of students per dimension in cycle 2 are presented in the following table.

Table 6. Mathematical Connection Ability for each Indicator in Cycle 2

No	Indikator Kemampuan Koneksi Matematis	Skor Rata-rata	Kategori
1	Mengintegrasikan informasi	80	Baik
2	Membuat koneksi dalam dan antar matematika	66	Cukup
3	Menetapkan rumus	66	Cukup
4	Memecahkan masalah tidak rutin	79	Baik

Table 6 shows that mathematical connection skills in the indicators of integrating information and solving non-routine problems are in the good category. While the indicators of making connections within and between mathematics and determining formulas are still in the sufficient category.

Table 7. Conclusion of the Score Distribution of Mathematical connections Ability of each group

No.	Group Learning	Cycle 1		Cycle 2	
		Mean	Category	Mean	Category
1	Group 1	54	Less	66	Enough
2	Group 2	67	Enough	74	Good
3	Group 3	84	Good	88	Very Good
Classical Average		**68**	**Enough**	**75**	**Good**

Table 8. Conclusion of Mathematical Connection Capacity by Indicator

No.	Indicators of mathematical connections	Cycle 1 Group Learning			Mean	Cycle 2 Group Learning			Mean
		I	II	III		I	II	III	
1	Integrating information	58	73	84	**72**	75	79	91	**80**
2	Creating a connection within and between mathematics	50	58	75	**60**	54	63	81	**66**
3	Using a math equation or formula	50	58	75	**60**	54	63	81	**66**
4	Solving uncommon problems	50	71	94	**72**	58	80	91	**79**

The results of data analysis from research conducted over two cycles with mathematics learning content of statistical material on bar chart material for grade 4 students show an increase in mathematical connection skills from the sufficient category in cycle I to the good category in cycle 2. Although in general the mathematical connection skills of grade 4 students have been in the good category after this research action is carried out, it still needs to be improved through the next learning process. In addition, the mathematical connection skills possessed are also not optimal considering that two indicators used as research benchmarks are still in the sufficient category, namely indicators of making connections within and between mathematics and indicators of determining formulas. Indicators of making connections within and between mathematics are seen from how students can formulate mathematical problems/ construct mathematical models. The indicator of determining mathematical formulas looks at the ability of students to apply strategies to solve various problems both similar and new problems in or outside of mathematics.

5. Conclusion

One successful way to close the learning gap is to use the Teaching at the Right Level (TaRL) approach through project-based learning. This learning gap is thought to be the source of pupils' disparities in the field of connection mathematical ability. Students with little prior knowledge will fall behind and will be unable to participate in learning activities in the following class. These students will then lose interest in learning, which must be handled immediately so that they do not fall behind. Assessment is intended to test students' starting ability, whereas grouping is intended to get learning based on their ability level. Following grouping, learning is carried out in accordance with their ability.

Based on research conducted on learning mathematics statistics material through a project-based learning model using Teaching at the Right Level, it is known that the mathematical connections of grade 4 students increase. This is shown through the results

of initial observations, students have mathematical connection skills with an average score of 61 in the sufficient category. After the implementation of cycle 1 action, the average score of mathematical connection ability increased to 68 although it was still in the sufficient category. In cycle 2, the math connection ability score again increased to 75 and was included in the good category.

Teachers should understand students based on their individual abilities. This affects the application of various actions that can optimize each learner's potential. Teachers' abilities that need to be honed and developed include classroom learning planning, application of materials, selection of methods, and development of evaluation methods that will be used to improve the quality of teaching and learning. Teachers are advised to understand the weaknesses and strengths of each learner's ability because students have different abilities, especially mathematical connection abilities.

6. Acknowledgement

The researcher would like to thank the supervisor, collaborators, and grade 4 students for their help, cooperation, support, and participation so this class action research can be compiled and completed properly.

7. References

Arikunto, S. (2021). *Penelitian tindakan kelas*: Edisi revisi. Bumi Aksara.

Banerji, R., & Chavan, M. (2016). Improving literacy and math instruction at scale in India's primary schools: The case of Pratham's Read India program. *Journal of Educational Change,* 17(4), 453–475. doi:10. 1007/s10833-016-9285-5

Bell, F. H. (1978). *Teaching and Learning Mathematics in Secondary School.* (Cetakan kedua). Dubuque, Iowa: Wm. C. Brown Company Publisher

Bergeson, T. (2000). *Teaching and learning mathematics*. State Superintendent of Public Instruction.

Coxford, A.F. (1995). "The Case for Connections", dalam *Connecting Mathematics across the Curriculum*. Editor: House, P.A. dan Coxford, A.F. Reston, Virginia: NCTM

Lusardi, A. (2012). Numeracy, Financial Literacy, and Financial Decision-Making. *Numeracy,* 2(1), 34–67. doi:10.5038/1936-4660.5.1.2

Micovich, A.K. and Monroe, E.E. (1994). Making Mathematical Connection Across the Curriculum: Activities to Help Teachers Begin. *School Science and Mathematics*. 94(7).

Muskania, T. R., & Wilujeng, I. (2017). Pengembangan perangkat pembelajaran project-based learning untuk membekali foundational knowledge dan meningkatkan scientific literacy. *Cakrawala Pendidikan*, *01*, 34–43.

National Council of Teacher of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics.* Virginia: Reston.

Parwati, G. A. P. U., Rapi, N. K., & Rachmawati, D. O. (2020). Penerapan model pembelajaran inkuiri terbimbing untuk meningkatkan kemampuan berpikir kritis dan sikap ilmiah siswa SMA. *Jurnal Pendidikan Fisika Undiksha*, *10*(1), 49–60.

Peraturan Menteri Pendidikan Nasional No 22 Tahun 2006 Tentang Standar Isi, Depdiknas (2006).

Prastyo, H. (2020). Kemampuan matematika siswa Indonesia berdasarkan TIMSS. *Jurnal Padegogik*, *3*(2), 111–117. https://doi.org/10.35974/jpd.v3i2.2367

Purpura, D. J., Hume, L. E., Sims, D. M., & Lonigan, C. J. (2011). Early literacy and early numeracy: The value of including early literacy skills in the prediction of numeracy development. *Journal of Experimental Child Psychology*, 4(1), 145–156. doi: 10.1016/j.jecp.2011.07.004

Rohendi, D., & Dulpaja, J. (2013). Connected Mathematics Project (CMP) model based on presentation media to the mathematical connection ability of junior high school student. *Journal of Education and Practice*, *4*(4), 17–22.

Sawyer, A. (2008). Making Connections: Promoting Connectedness in Early Mathematics Education. In M. Goos, R. Brown, & K. Makar (Eds.), *Merga Conference Proceedings* (pp. 429–435). Mathematics Education Research Group of Australasia Inc.

Shafer, M.C., & Foster, S. (1997). The Changing Face of Assessment. *Principled Practice in Mathematics & Science Education,* 1(2), 1-8

Sumarno, U. (2014) Pengembangan hard skill dan soft skill matematik bagi guru dan siswa untuk mendukung implementasi kurikulum 2913. *Prosiding Seminar Nasional Pendidikan Matematika,* Bandung, Vol 1, p.4-15

The National Council of Teachers of Mathematics, I. (2000). *Principles Standards for School Mathematics*. The National Council of Teachers of Mathematics, Inc.

Tout, D. (2020). Evolution of adult numeracy from quantitative literacy to numeracy: Lessons learned from international assessments. *International Review of Education,* 23(3), 456–478. doi:10.1007/s11159-020- 09831-4

Wena. (2009). *Strategi Pembelajaran Inovatif Kontemporer*. Jakarta: Bumi aksara.

Wulandari, D. (2012). Pengaruh Kompetensi Pedagogik dan Kompetensi Profesional Guru terhadap Economic Literacy melalui Prestasi Belajar Siswa Kelas XII IPS di SMA Kota Malang. *Jurnal Pendidikan Humaniora.*