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Improving Mathematical Connection Capability and Learning Outcomes Through Problem-Based Learning Model

Yoga Marga Mahendra*, Husamah, Budiono
Teacher Professional Education, Universitas Muhammadiyah Malang, Indonesia
*yogamarga23@gmail.com

ABSTRACT

This research is motivated by the low ability of students' mathematical connections and student learning outcomes in learning mathematics in grade IV of elementary school. Based on these problems, this study aims to improve mathematical connection skills and student learning outcomes through problem-based learning models in class IV mathematics learning whole numbers. The research subjects were fourth-grade students at SDN Mojorejo 1 Kota Batu. Data collection is done by testing and documentation. This research uses descriptive quantitative and qualitative analysis with the type of PTK research (classroom action research) by adapting the Kemmis and Taggart models which consist of four stages of planning namely, action, observation, and reflection carried out in two cycles. The results showed that the minimum mixed value of students in the pre-cycle obtained a result of 10%, then increased by 40% in cycle I, students' mathematical connection ability was 50% then increased by 39% to 89% in cycle II. In addition, the results of the average score, namely in the pre-cycle of students' mathematical connection ability, namely 45% then increased by 24% to 69% in cycle I then increased again by 19% to 80%. This shows that there is an increase in the ability of mathematical connections and student learning outcomes after learning using the problem-based learning (PBL) model.

Keywords: Connection Mathematics, Learning Outcomes, Problem-Based Learning

ABSTRAK

Penelitian ini dilatar belakangi oleh rendahnya kemampuan koneksi matematis siswa dan hasil belajar siswa dalam pembelajaran matematika di kelas IV sekolah dasar. Berdasarkan permasalahan tersebut penelitian ini bertujuan untuk meningkatkan kemampuan koneksi matematis dan hasil belajar siswa melalui model pembelajaran *Problem Based Learning* pada pembelajaran matematika kelas IV materi bilangan cacah. Subjek penelitian adalah siswa kelas IV SDN Mojorejo 1 Kota Batu. Pengumpulan data dilakukan dengan tes dan dokumentasi. Penelitian ini menggunakan analisis deskriptif kuantitatif dan kualitatif dengan jenis penelitian PTK (Penelitian Tindakan Kelas) dengan mengadaptasi model kemmis dan tagart yang terdiri dari empat tahap yaitu perencanaan, tindakan, observasi dan refleksi yang dilaksanakan dalam dua siklus. Hasil penelitian menunjukan nilai kriteria minimum siswa pada pra siklus mendapatkan hasil sebesar 10 %, kemudian meningkat sebesar 40 % pada siklus I, kemampuan koneksi matematis siswa yaitu sebesar 50% kemudian meningkat sebesar 39% menjadi 89% pada siklus II. Selain itu, hasil nilai rata-rata yaitu pada siklus kemampuan koneksi matematis siswa yaitu sebesar 45% kemudian meningkat sebesar 24% menjadi 69% pada siklus I kemudian meningkat kembali sebesar 19 % menjadi 80 %. Hal ini menunjukkan bahwa adanya peningkatan kemampuan koneksi matematis dan hasil belajar siswa setelah melakukan pembelajaran menggunakan model *Problem Based Learning* (PBL). Peningkatan kemampuan koneksi matematis dan hasil belajar terjadi karena adanya tindakan terhadap proses pembelajaran yang dilakukan dengan menerapkan prinsip-prinsip pada model pembelajaran *Problem Based Learning*. Penerapan model pembelajaran *Problem Based Learning* membuat siswa belajar semakin aktif dalam proses pembelajaran.

Kata kunci: Koneksi Matematis, Hasil Belajar, Problem-Based Learning

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Introduction

Mathematics learning is very closely related to daily life and exists at various levels, one of which is basic education (Mumcu & Aktaş, 2018). Mathematics serves as a conceptual tool in solving problems related to everyday life. The characteristic of mathematics is that it can develop students to be able to think logically, systematically, and critically and be able to deal

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with various problems in their daily lives. The rationale and goals of the independent curriculum state that learning mathematics aims to develop various abilities that students must have, one of which is the ability to make mathematical connections (Kemendikbud, 2022). Mathematical connection is the ability to link between mathematical concepts, relate mathematics to other fields and relate mathematics to everyday life (Arthur et al, 2018.; NCTM, 2002).

García-García & Dolores-Flores (2018) state that the ability to make mathematical connections is a very important ability for elementary school students to have. This is because mathematics is very close and is felt directly by students in their lives. For example, buying and selling, finance, and other activities related to mathematics (Hennessey et al., 2012). Mathematical connection ability can make students understand the implications of the mathematical material they have learned. A mathematical connection has 3 indicators, namely connecting between mathematical concepts, mathematical concepts with other fields, and connect mathematical concepts to everyday life (Agustini et al., 2017; Maulida et al., 2019).

Specifically, it can be explained that the ability of students' mathematical connections at school is still very low. This is proven through the results of the mathematical connection ability test which shows that only 24% of students can understand mathematical connections based on their ability indicators. The results of interviews with students also stated that only 16% of students were able to understand the relationship between mathematical concepts, 12% of students were able to understand the relationship between mathematical concepts and other fields and 10% of students were able to understand the function of mathematics in everyday life. The low ability of mathematical connections in the field is directly proportional to the learning outcomes possessed by students in mathematics. The results of students' daily tests in mathematics showed that 78% of students were still below the minimum completeness (KKM).

The results of the PISA survey state that the mathematical connection ability of elementary school students in Indonesia is low. Indonesia only achieves level 2 capability of 28% and level 5 of 1% and places it in 73rd place out of 79 countries (OECD, 2019). In addition, the TIMSS survey which can describe math skills at the elementary school level states that Indonesia is at the 44th level out of 49 countries (TIMMS, 2017). This becomes the basis that the development of mathematics learning needs more attention. The two surveys were developed based on the classification of mathematical connection abilities, namely C4, C5, and C6 (Lindquist et al., 2019). So it can be drawn that the ability of Indonesian students' mathematical connections is low.

The questions developed in the PISA and TIMMS surveys use high-level questions according to their cognitive domain. The division of cognitive domains according to Bloom's Taxonomy describes that the PISA and TIMMS surveys were developed based on classifications at C4, C5, and C6 namely analyzing, evaluating and creating. These questions are related to the development of problem solving including problem analysis, formulating solutions and communicating them. The development of the PISA and TIMSS tests is inseparable from the mastery of students' mathematical connection abilities. It was concluded that when the results of PISA and TIMSS showed that Indonesian students were low, this meant that one of the student's mathematical abilities was also low. One of these abilities is a mathematical connection because the development of mathematical connection ability is in the C4, C5 and C6 cognitive domains.

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When viewed from the theory of constructivism, learning is a process of assimilating and associating knowledge and experience (Padmavathy, 2013). So that learning outcomes are abilities possessed by students after experiencing the process or learning experience. Learning outcomes will describe students' understanding of the material. So that when student learning outcomes are low, it is likely that students' understanding of the material is also low. Learning outcomes will show a change in results that are carried out as a result of a process that causes functional changes (Romli, 2018). Learning outcomes can also be defined as changes in behavior that occur toward students after participating in the teaching and learning process in accordance with educational goals (Dalyono, 2009). Bloom divides learning outcomes into 3 domains, namely cognitive, affective, and psychomotor (O'Grady et al., 2014).

Facts from the field conclude that the low ability of mathematical connections and student learning outcomes are influenced by the learning model used by teachers in less diverse classes. The learning model used does not develop connection skills and cannot improve student learning outcomes. The teacher only uses direct explanatory learning models in class via the blackboard. So we need a learning model that can improve the ability of mathematical connections and students' mathematics learning outcomes.

The learning model that can be developed to increase the ability of mathematical connections and student learning outcomes is the Problem-Based Learning model. Problem-based learning can make material delivered authentically from problems in everyday life (Setyadi & Saefudin, 2019). Problem-Based Learning (PBL) is a learning model that can improve students' abilities (Moallem et al., 2019). Problem-based learning is very important in learning because it is problem-based. The learning model encourages students to be actively involved in learning activities to construct their knowledge based on the problems given by educators/teachers (Arifin & Wijaya, 2021). The importance of Problem-Based Learning is in line with what is being conveyed by the educator/teacher (Gonsalves et al., 2019). Learning will be much more meaningful when learning is wrapped using this model because students can play an active role in learning (Yew & Goh, 2016).

Based on the previous explanation, researchers are interested in applying problem-based learning models to improve students' mathematical connection skills and learning outcomes in mathematics. The purpose of this research is to improve the ability of mathematical connections and student learning outcomes through the application of problem-based learning (PBL) learning models. The urgency of this research is related to mathematical connection skills which are crucial and must be possessed by students as well as student learning outcomes which must be improved so that student's understanding of mathematical material can increase so that students will understand much more about the implications of mathematics itself.

Research Methods

This research is a form of classroom action research (PTK) that was carried out at SD Negeri Mojorejo 01 Kota Batu. The research design that is used as a reference in this research is using classroom action research from Kemmis & Mc. Taggart in the form of a spiral from cycle I to the next cycle (Fatimah & Purba, 2021). In planning, Kemmis's (Sukidin, 2002)spiral system of self-reflection begins with plans, actions, observations (observations), reflections, and re-planning which are the general basis of a square off on problem-solving. Classroom Action Research (CAR) is conducted in the odd semester of the 2022/2023 school year for 2 months. This classroom action research is a descriptive qualitative research method. Descriptive research is a method for explaining the real situation of a group or individual condition precisely

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(Fatimah & Purba, 2021). And the qualitative research method is research that produces descriptive data from the subject or the subject's behavior is observed.

The subject in this study was class IVB at SD Negeri Mojorejo 01 Kota Batu as the subject of 2 classes with a total of 28 students (12 boys and 16 girls). The researcher chose this class with the consideration that the results of the pre-action were that there were still many students who had not finished learning Mathematics. Action research (CAR) is expected to improve the learning process that has been carried out by the teacher. The problem that became the focus of the study in this classroom action research was the low ability of mathematical connections and the value of mathematics learning outcomes in class IVb students of SD Mojorejo 1 Batu City. The CAR research design can be carried out in several cycles depending on field results. One cycle consists of planning, action, observation, and reflection. The following cycle of the stages of classroom action research can be seen in the Figure 1.

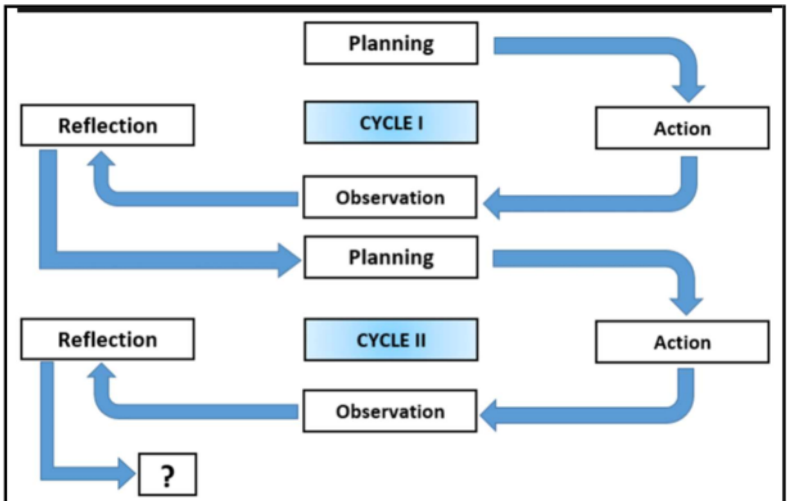

Figure 1. Stages in Classroom Action Research (PTK)

Research procedures carried out by researchers in improving mathematical connection skills and learning outcomes in mathematics using the PBL learning model consist of Cycle I research procedures and Cycle II research procedures where each procedure consists of planning and action. This planning stage is used by researchers to facilitate readiness at the implementation stage of the action. The preparations in this study were: (1) observing student learning in class IVb in order to obtain an overview of learning activities, and student characteristics and to collect initial student data; (2) preparing a research plan and time; (3) reviewing competency standards, basic competencies, and subject matter and also preparing learning tools consisting of the syllabus, lesson plans, worksheets, evaluation questions, student answer keys, and research instruments; and (4) preparing the media used in learning activities in cycle I.

At the implementation stage of Cycle I, the researcher developed a learning planning scenario or lesson plan so that the actions in the research could take place properly and be arranged according to chronology. During the learning implementation process, the researcher used the PBL learning model. Meanwhile, colleagues who act as collaborators will observe student

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participation and learning activities during the learning process. During the first meeting in the cycle, I discussed the arithmetic operations of adding and subtracting whole numbers. At the observation stage, the researcher observed, recorded, and recorded all student activities during the teaching and learning process. Based on observations made simultaneously using student observation sheets, between action and observation is a unity.

Through this observation, researchers can find out how far the PBL learning model can be applied. Observations were made by collaborators/colleagues who understand mathematics learning. The collaborator's tasks are as follows: (1) assess the learning process carried out by the teacher using the instruments that have been prepared; (2) observe students and conduct research on mathematics learning outcomes using the PBL learning model; and (3) observe the activeness of students in the learning process. Reflection is the result of observations and evaluation results in the research process and becomes the basis for preparing an action plan at the next meeting so that it can run smoothly and get better results from the next meeting or in cycle II.

The research procedure in cycle II begins with the planning stage. Before the research was carried out, the researcher first made a plan. In the planning stage, the researcher carried out several activities such as looking for references related to the steps of Classroom Action Research and how they were structured, together with the teacher as a collaborator, the researcher discussed the research objectives and reviewed class IV mathematics material relating to multiplication and division. Researchers plan to learn scenarios and also prepare supporting facilities to carry out these action scenarios. The next stage is to carry out cycle II actions by carrying out learning using the PBL model. At the observation stage, the researcher observed, recorded, and recorded all student activities during the teaching and learning process.

Data collection techniques in this study were tests and observations. The test used is a subjective test for students to determine students mathematical connection abilities and see student learning outcomes. The research instrument consisted of 10 questions developed based on mathematical connection indicators. Observations in this study were carried out to observe the activities of teachers and students in applying the problem-based learning model in the classroom.

Data analysis techniques used by researchers are quantitative and qualitative data analysis techniques. Qualitative data is in the form of descriptions containing findings during the process of learning activities. The data analysis technique used in this study consisted of three stages, namely data reduction, data exposure, and conclusion. Data analysis techniques are explained as follows: 1) Data reduction. Data reduction in this study is writing in a descriptive way about learning activities carried out by teachers and students. 2) Data Exposure, Data exposure in this study is by describing, and also making differences in learning activities in cycle 1 and cycle 2; 3) Conclusion. The conclusion of the data in this study is the process of taking the essence of the data presented in descriptive form.

The data analysis used by researchers to analyze the increase in mathematical connection ability is in the form of quantitative data/numbers including the following: 1) based on formula 1, scoring the results of the mathematical connection ability test, the assessment is carried out by calculating the student's score with an ideal score from the mathematical connection indicator.

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$$Mark = \frac{score\ obtained\ by\ students}{maximum\ total\ score} \times 100\% \qquad (1)$$

2) Determination of Criteria. After obtaining the results of the student evaluation scores, the researcher determines the criteria for measuring the abilities of the students. The minimum completeness criterion set by the school is 75. Tabel 1 show the category of mathematical connection abilities.

Table 1. Category of Mathematical Connection Ability

Mastery Level	Criteria
75% - 100 %	Very good
50% - 75%	Good
25% - 50%	Not enough
0% - 25%	Very less

The selection of the class average is determined from the formula below: The selection of the class average is determined from the formula 2 below:

$$R = \frac{the\ total\ value\ of\ all\ student}{the\ number\ of\ student} \qquad (2)$$

The assessment of the percentage of learning completeness is determined from the formula 3 below:

$$P = \frac{number\ of\ student\ who\ completed}{the\ number\ of\ students} \times 100\% \qquad (3)$$

Research is said to be successful if there is a change marked by an increase in the ability of mathematical connections. the increase in mathematical connection ability can be known by calculating the difference in values in cycle 1 and cycle II. This section contains a summary of research methods, including types of research, research settings, research subjects (population and sample), data collection techniques, data validity, and data analysis techniques.

Result and Discussions

In this section, the results of classroom action research that have been carried out by researchers regarding mathematical concepts in class IV elementary school students will be described using the problem-based learning model that has been carried out and its discussion. The learning principle used in this study consists of 5 stages, namely (1) orienting students towards problems; (2) organizing students to learn; (3) guiding individual and group investigations; (4) developing and presenting works; and (5) analyzing and evaluating.

Each cycle has research procedures, namely the pre-research, implementation (cycle I and cycle II), observation, and reflection stages. At the pre-research stage, the researcher carried out sit-in activities or observations for one week in the class that would be used as research and conducted interviews with the teacher concerned. The implementation stage consists of two cycles namely cycle I and cycle II. At this stage, it is divided into two parts, namely action planning, and implementation of actions that coincide with observation or observation

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activities. Observations in learning are carried out to observe the learning process and write down findings and collect data to increase understanding of mathematical concepts to be used as material for reflection for further learning. Observation is a direct observation of activities carried out by observers who aim to collect data This is in line with what was conveyed by (Sukmadinata, 2005).

As for the indicators of the mathematical connection chosen by the researcher, they adopted from NCTM (National Council of Teachers of Mathematics) (NCTM, 2002), namely, there are three indicators namely 1) Relation to mathematical concepts; 2) Relationship between mathematical concepts and other concepts; and 3) The relationship between mathematics and everyday life. The description of the learning process contained in the research is as follows: a) Orienting students to problems (students observe and understand the problems presented by the teacher from the phenomena given by the teacher); b) Organizing students for learning (Students discuss and share tasks to find data/materials/tools needed to solve problems); c) Guiding individual and group investigations (Students carry out investigations (looking for data sources/references/sources for group discussion materials. d) Develop and present work results (groups hold discussions to produce solutions to problem-solving and the results are presented/presented in the form of works); e) Analyze and evaluate the problem-solving process (each group makes a presentation, the other groups give their appreciation. The activity is continued by summarizing/making conclusions according to the input obtained from other groups.)

Mathematical connection ability is measured using a self-evaluation test given at the end of each learning cycle. This test was conducted to find out the results of understanding mathematical concepts in students based on predetermined indicators in learning mathematics using the PBL learning model. In this study, the tests were made in the form of Individual Evaluation Sheets (LESI) and Student Worksheets (LKPD). This is in line with the opinion of (Riyanto, 2001) who said that the test is a tool to measure students' cognitive, affective, and even psychomotor abilities with a series of questions both verbal and non-verbal.

Based on the research results obtained in the Pre-Cycle, most students still have not reached the criteria of mathematical connection ability. There are four criteria for classifying mathematical connection abilities. So it can be concluded that students still do not fulfill the three indicators of mathematical connection ability, namely 1) connecting between mathematical concepts; 2) connecting mathematical concepts with other subjects; and 3) the relationship between mathematics and everyday life. The following is the acquisition of each criterion obtained from the Pre-Cycle.

Based on Figure 2 is Gain Chart of Pre-Cycle Mathematical connection Value Indicator Gain, the percentage of students who reached the first criterion was very low (0% -25%) at 32%, it can be concluded that there were 9 students who reached the first criterion. The percentage of students who achieve the second criterion is less (26% - 50%) than 35%, it can be concluded that there are 11 students who achieve the second criterion. The percentage of students who reach the third indicator is good (51% - 75%) 21%, so it can be concluded that there are students who reach the third criterion as many as 6 people. And finally, the percentage of students who reach the fourth indicator, which is very good (76% - 100%) is 7%, it can be concluded that there are 2 students who reach the second criterion.

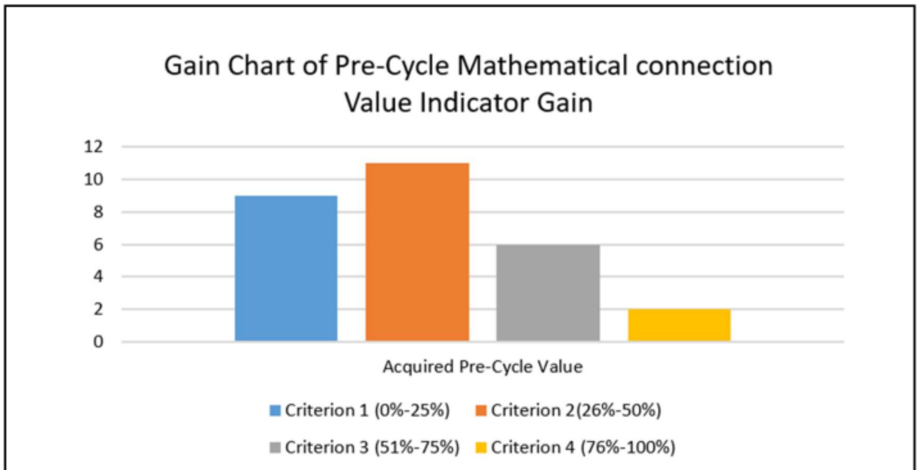

Figure 2. Gain Chart of Pre-Cycle Mathematical connection Value Indicator Gain

Acquisition of the most criteria, namely on the first and second criteria, which is equal to 71% and as many as 20 students. Whereas the third and fourth criteria only achieved a gain of 29% and as many as 8 students. So it can be concluded that the mathematical connection ability of elementary school students is low.

Researchers analyzed the impact of the low ability of mathematical connections due to the use of learning models that are less diverse. Students do not feel interested in learning mathematics and the learning model developed does not support the mathematical connection ability. Students are only used to working on problems procedurally and problems and questions that are usually developed by teachers are not based on mathematical problems. So that the indicators of mathematical connection ability in elementary schools do not develop or are not facilitated in the learning process.

Overall, student scores in the Pre-Cycle were not very satisfactory because there were still many students who did not complete and scored below 75. Because if we refer to the Minimum Completeness Criteria (KKM) set by the school, that is, the minimum score is 75, it means only three students passed with scores above 75. For more details, the following is the percentage of students who meet the minimum completeness criteria in the Pre-Cycle.

Based on the Figure 3 is Data diagram for Pre-Cycle Student Mastery Acquisition, students with incomplete grades are greater than students with completed grades. The percentage of students who did not complete was 89% or around 25 students out of a total of 28 students. While the percentage of students who passed was only 11% or about 3 people out of a total of 28 students. These data made researchers conduct research related to the application of problem-based learning models to improve mathematical connection abilities and student learning outcomes using the CAR approach method which consisted of 2 cycles.

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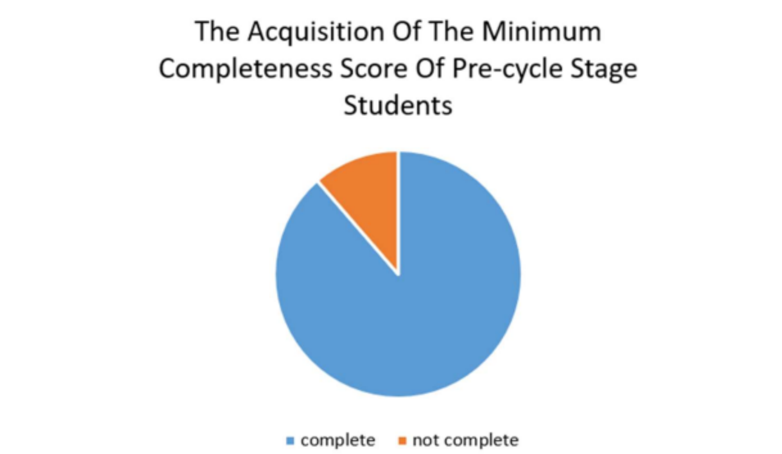

Figure 3. Data diagram for Pre-Cycle Student Mastery Acquisition

Meanwhile, based on the results of classroom action research in cycle I, most students had not achieved good and very good criteria based on the criteria of mathematical connection ability. The following is the acquisition of each criterion obtained from cycle I.

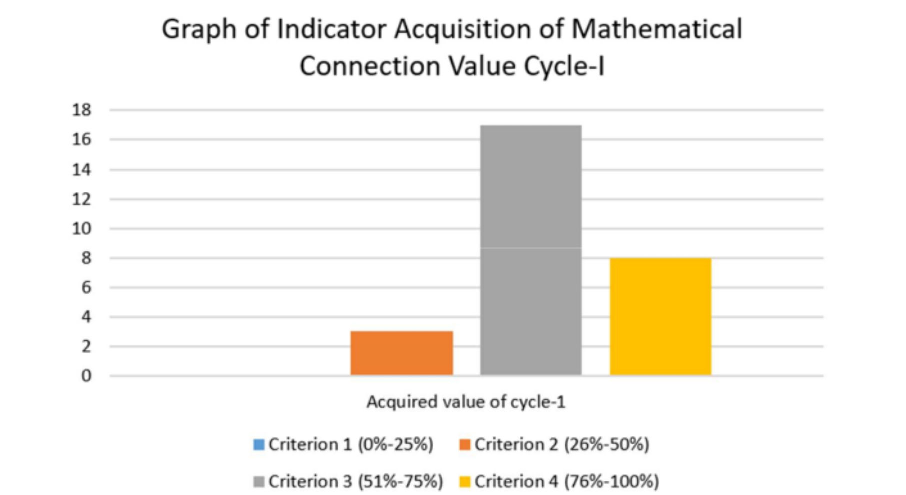

Figure 4. Graph of Indicator Acquisition of Mathematical Connection Value Cycle I

Based on Figure 4 is Graph of Indicator Acquisition of Mathematical Connection Value Cycle I, the percentage of students who reach the first criterion is very low (0% -25%) at 0%, it can be concluded that there are no students who reach the first criterion. The percentage of students who reach the second criterion is less (26% - 50%) than 10%, it can be concluded that there are 3 students who reach the second criterion. The percentage of students who reach the third indicator is good (51% - 75%) is 60%, so it can be concluded that there are 17 students who reach the third criterion. And finally, the percentage of students who reached the fourth

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indicator, namely very good (76% - 100%) was 28%, it can be concluded that there were 8 students who reached the second criterion. So it can be concluded that the mathematical connection ability of school students is still not optimal.
Researchers analyzed the impact of the still not maximal mathematical connection ability because students were not used to using problem-based learning models. In addition, students are not used to the problems given to students so this ability is not maximized.

Overall, the acquisition of student scores in cycle I was balanced between students who did not complete and those who completed and scored below 75. Because if we refer to the Minimum Completeness Criteria (KKM) set by the school, the minimum score is 75, meaning 14 students pass with a score above 75. For more details, the following is the percentage of students who meet the minimum completeness criteria in cycle I.

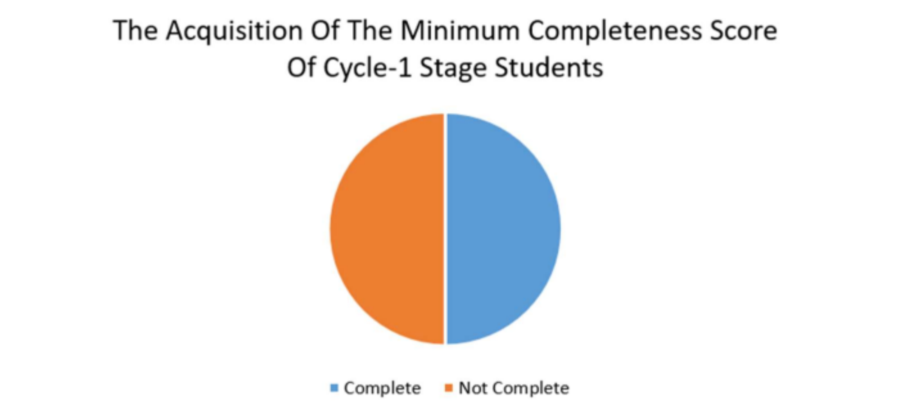

Figure 5. Data diagram of Cycle I Student Mastery Acquisition

Based on Figure 5 is Data diagram of Cycle I Student Mastery Acquisition, students with incomplete grades are the same as students with completed grades. The percentage of students who did not complete was 50% or around 14 students out of a total of 28 students. Meanwhile, the percentage of students who passed was only 14% or around 14 students out of a total of 28 students.

Like the data that has been described, in cycle I there was still many students who had not been able to reach the established mathematical connection ability criteria and there were still students who scored below the minimum completeness criteria. For this reason, it is necessary to make improvements in the learning process based on reflections from the previous cycle.

Meanwhile, based on the results of class action research in cycle II. Each indicator has different achievements according to the understanding of students. The following is the acquisition of each indicator obtained from cycle II.

Based on figure 6 is Graph of Indicator Acquisition of Mathematical Connection Value Cycle II, the percentage of students who reach the first criterion is very low (0% -25%) at 0%, it can be concluded that there are no students who reach the first criterion. The percentage of students who reach the second criterion is less (26% - 50%) than 0%, it can be concluded that there are no students who reach the second criterion. The percentage of students who reach the third

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indicator is good 51% - 75% by 20%, it can be concluded that there are students who reach the third criterion as many as 8 people. And finally, the percentage of students who reached the fourth indicator was very good (76% - 100%), namely 71%, it can be concluded that there were 20 students who reached the four criterions.

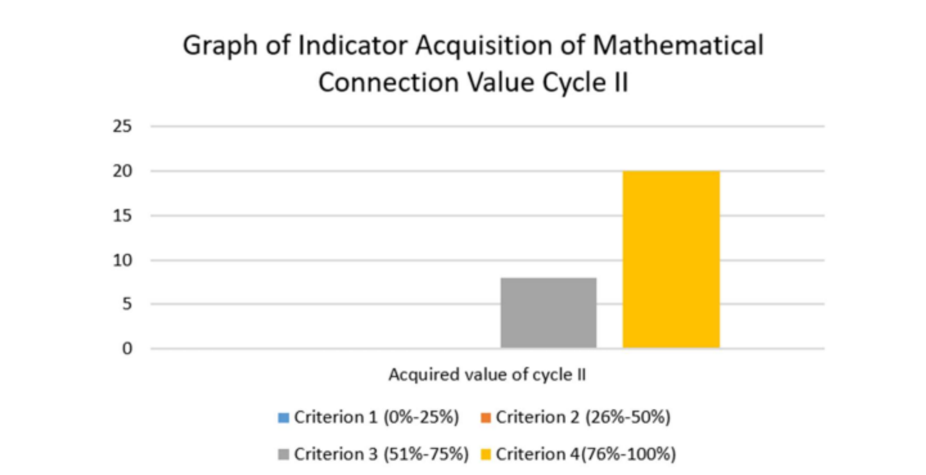

Figure 6. Graph of Indicator Acquisition of Mathematical Connection Value Cycle II

When compared with the results in the first cycle, the results of the second cycle can be said to be much better. Each student is able to show progress in this second cycle. Most students have been able to achieve the minimum completeness criteria set by the school. The following is the data on the acquisition of student completeness in cycle II.

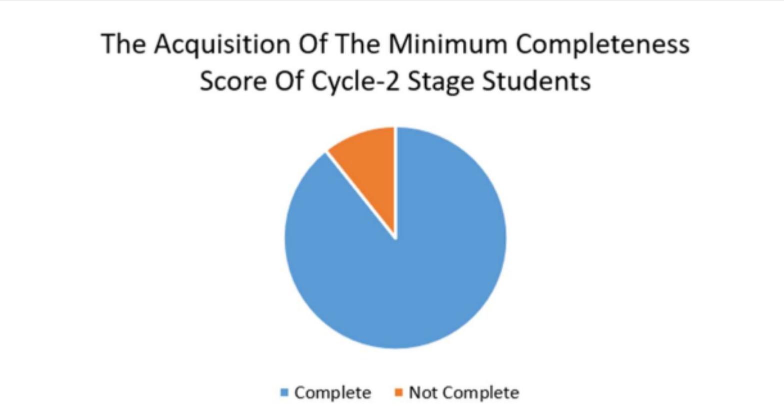

Figure 7. Data diagram of Cycle II Student Mastery Acquisition

Based on Figure 7 is Data diagram of Cycle II Student Mastery Acquisition, the majority of students get grades according to the specified KKM, which is above 75. The percentage of students who complete is 89% or around 25 students out of a total of 28 students. While the percentage of students who did not complete was only 11% or about 3 people out of a total of 28 students. This is inversely proportional to the previous cycle, namely 3 people completed it,

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while 25 people did not complete it. The following is the percentage of mastery of mathematical connections in mathematics learning whole number material obtained by class IV students.

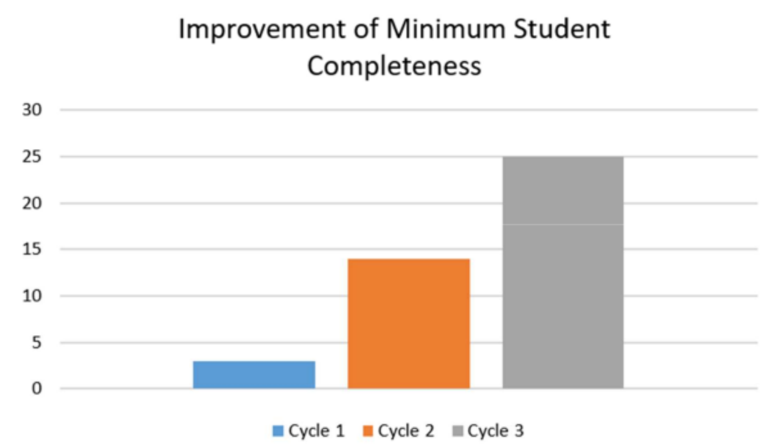

Figure 8. Improvement of Minimum Student Completeness

From Figure 8 is improvement of minimum student completeness, it can be seen that there is an increase in the mathematical connection ability obtained by students. Based on the minimum criterion value of students in the pre-cycle, the results were 10%, then increased by 40% in cycle I, students' mathematical connection abilities were 50%, then increased by 39% to 89% in cycle II. For more details, the following will provide a comparison of the average values in the pre-cycle, cycle I, and cycle II.

From Figure 9, it can be seen that there is an increase in the mathematical connection ability obtained by students. The acquisition of this comparison is obtained from a comparison of the results of the average student scores. In the pre-cycle, the students' mathematical connection ability was 45% then increased by 24% to 69% in cycle I then increased again by 19% to 80%. The learning process using the Problem-Based Learning model can be seen in the picture below.

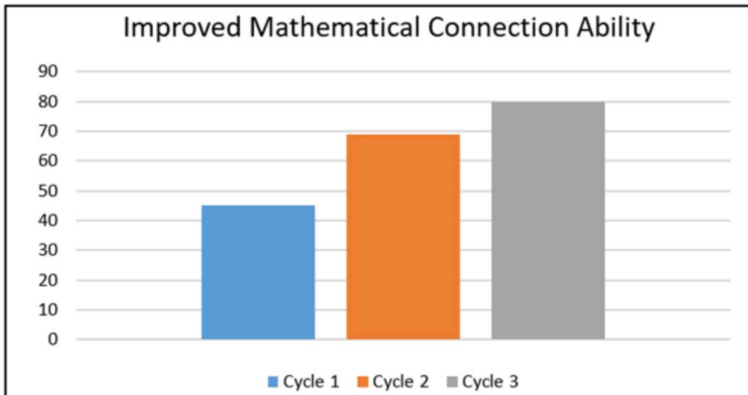

Figure 9. Improved Mathematical Connection Ability

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Problem-based learning is considered effective for students marked by giving contextual problems (Marchy et al., 2022). The problems raised are very real for students and are usually experienced directly by students (Sujarwo, 2020).

Figure 10. The Learning Process Using the Problem Based Learning Model

From figure 10 is the learning process using problem based learning. In the picture it can be seen that there is a group discussion process to solve a mathematical problem. The mathematical problems presented are in the form of whole number material that students must solve with their group mates.

Figure 11. Student Activities Using Problem Based Learning Models

From figure 11 is student Activities Using Problem Based Learning Models. These activities describe active students in the learning process. Students explain the multiplication of whole numbers in front of the class using the mathematical concepts that students have learned.

By applying the Problem-Based Learning model, students become more actively involved in learning and are able to find their own knowledge based on the experiences experienced by each student. In addition, the Problem-Based Learning model can also strengthen students' mathematical connection abilities because it applies principles that support sharpening these mathematical connection abilities. This is obtained because the principle of problem-based learning is synonymous with giving problems in the real world. So that students will be familiar with these problems and in accordance with the indicators of mathematical connection ability. Student learning outcomes will be in line with their connection abilities. When connection ability increases, student learning outcomes also increase. This can also be evidence to strengthen data collection carried out by researchers and is in line with what was conveyed by Tabah (2020) that the use of problem-based learning models can improve mathematical connection abilities and learning outcomes in elementary school students.

Problems in problem-based learning are studied based on and related to real life (Tawfik, 2015) so that the learning process is based on authentic and real problems. This can encourage mathematical connection skills because one indicator of mathematical connection is the relationship between mathematics and everyday life. The learning process of Problem Based Learning can enable students to actively participate in the process of building understanding rather than concentrating on memorizing knowledge (Marchy et al., 2022). The PBL learning process can make learning more understandable to students.

Conclusion

The application Problem-Based Learning model implemented in mathematics learning has 5 stages, namely orienting students to problems, organizing students to learn, guiding individual and group investigations, developing and presenting work, and analyzing and evaluating problem-solving processes. The application of this PBL model is centered on students being actively involved in the learning process. The application of the PBL model in cycles I and II has been carried out sufficiently and obtained increased results in terms of mathematical connection abilities and learning outcomes.

The increase in learning outcomes for students in grade IV of this elementary school has increased, namely based on the minimum criterion value of students in the pre-cycle to get a result of 10%, then it increased by 40% in cycle I, students' mathematical connection ability was 50% then increased by 39% to 89% in cycle II. In addition, the increase in mathematical connection ability can be seen from the results of the average value, namely in the pre-cycle of students' mathematical connection ability which was 45% then increased by 24% to 69% in cycle I then increased again by 19% to 80%.

From these results, it can be seen that aspects that support the development of mathematical connection abilities and student learning outcomes have increased due to action on the learning process carried out by applying the principles to this problem-based learning model. So it can be concluded that the ability of mathematical connections and learning outcomes of class IV students can be improved through the application of problem-based learning models.

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Bibliography

Agustini, R. Y., Suryadi, D., & Jupri, A. (2017). Construction of Open-Ended Problems for Assessing Elementary Student Mathematical Connection Ability on Plane Geometry. *Journal of Physics: Conference Series*, *895*(1). https://doi.org/10.1088/1742-6596/895/1/012148

Arifin, I. F, & Wijaya, A. M., (2021). Efektivitas Problem Based Learning Terintegrasi Nilai Budaya Pendhalungan Dalam Merajut Karakter Siswa. *SANDHYAKALA Jurnal Pendidikan Sejarah, Sosial Dan Budaya*, *2*(1), 89–103.

Arthur, Y. D., Owusu, E. K., Asiedu-Addo, S., & Arhin, A. K. (n.d.). *Connecting Mathematics To Real Life Problems: A Teaching Quality That Improves Students' Mathematics Interest*. *8*(4), 65–71. https://doi.org/10.9790/7388-0804026571

Dalyono. (2009). *Pengaruh Motivasi Belajar Terhadap Kesultan Belajar Siswa Kelas VIII SMP Negeri 3 Sampit Tahun Pelajaran 2016/2017*.

Fatimah, A. E., & Purba, A. (2021). Hubungan Resiliensi Matematis Terhadap Kemampuan Pemecahan Masalah Matematis Mahasiswa Pada Mata Kuliah Matematika Dasar. *Journal of Didactic Mathematics*, *1*(3), 151–157. https://doi.org/10.34007/jdm.v1i3.470

García-García, J., & Dolores-Flores, C. (2018). Intra-mathematical connections made by high school students in performing Calculus tasks. *International Journal of Mathematical Education in Science and Technology*, *49*(2), 227–252. https://doi.org/10.1080/0020739X.2017.1355994

Gonsalves, P. P., Hodgson, E. S., Kumar, A., Aurora, T., Chandak, Y., Sharma, R., Michelson, D., & Patel, V. (2019). Design and Development of the "POD Adventures" Smartphone Game: A Blended Problem-Solving Intervention for Adolescent Mental Health in India. *Frontiers in Public Health*, *7*. https://doi.org/10.3389/fpubh.2019.00238

Hennessey, M. N., Higley, K., & Chesnut, S. R. (2012). Persuasive Pedagogy: A New Paradigm for Mathematics Education. *Source: Educational Psychology Review*, *24*(2), 187–204. https://doi.org/10.1007/s

Kemendikbud. (2022). *Keputusan Kepala Badan Standar kurikulum dan pendidikan*.

Lindquist, M. A., Geuter, S., Wager, T. D., & Caffo, B. S. (2019). Modular preprocessing pipelines can reintroduce artifacts into fMRI data. *Human Brain Mapping*, *40*(8), 2358–2376. https://doi.org/10.1002/hbm.24528

Marchy, F., Murni, A., & Muhammad, I. (2022). The Effectiveness of Using Problem-Based Learning (PBL) in Mathematics Problem-Solving Ability for Junior High School Students. In *AlphaMath Journal of Mathematics Education* (Vol. 8, Issue 2).

Markus, S. (2019). *The Programme for International Student*.

Maulida, A. R., Suyitno, H., & Asih, T. S. N. (2019). Kemampuan Koneksi Matematis pada Pembelajaran CONINCON (Constructivism, Integratif and Contextual) untuk Mengatasi Kecemasan SIswa. *Prosiding Seminar Nasional Matematika*, *2*, 724–731. https://journal.unnes.ac.id/sju/index.php/prisma/

Moallem, M., Hung, W., & Dabbagh, N. (n.d.). *The Wiley Handbook of Problem-Based Learning*.

Mumcu, H. Y., & Aktaş, M. C. (2018). The Investigation of the Relationship Between Mathematical Connection Skills and Self-Efficacy Beliefs*. In *Conference Paper MATDER Journal of Mathematics Education* (Vol. 3, Issue 1).

Nana Syaodih Sukmadinata. (2005). *Metode Penelitian Pendidikan*. UPI Press.

NCTM. (2002). *Principles Standards and for*.

O'Grady, G., Yew, E. H. J., Goh, K. P. L., & Schmidt, H. G. (2014). One-day, one-problem: An approach to problem-based learning. In *One-Day, One-Problem: An Approach to*

Problem-based Learning. Springer Singapore. https://doi.org/10.1007/978-981-4021-75-3

Padmavathy, R. D. (2013). Effectiveness of Problem Based Learning In Mathematics. In *Issue-I: Vol. II*. www.shreeprakashan.com

Pirls, T. &. (2017). *TIMSS 2019 Assessment Frameworks*.

Riyanto. (2001). *Metedologi Penelitian Pendidikan* (SIC, Vol. 2001).

Romli, M. (2018). Profil Koneksi Matematis Siswa Perempuan Sma Dengan Kemampuan Matematika Tinggi Dalam Menyelesaikan Masalah Matematika. *Jurnal Ilmiah Pendidikan Matematika* , *1*(2), 145–157.

Setyadi, A., & Saefudin, A. A. (2019). Pengembangan modul matematika dengan model pembelajaran berbasis masalah untuk siswa kelas VII SMP. *Pythagoras: Jurnal Pendidikan Matematika*, *14*(1), 12–22. https://doi.org/10.21831/pg.v14i1.16771

Sujarwo, D. T. (2020). Pengaruh Problem Based Learning Terhadap Kemampuan Pemecahan Masalah Dan Self Efficacy Siswa Kelas VIII SMP Negeri 1 Patikraja. *AlphaMath : Journal of Mathematics Education*, *6*(1), 46. https://doi.org/10.30595/alphamath.v6i1.7948

Sukidin, dkk. (2002). *Manajemen Penelitian Tindakan Kelas*.

Tabah, D., Smk, S., & Purwokerto, D. (2020). *Destio Tabah Sujarwo Pengaruh Problem Based Learning Terhadap Kemampuan Pemecahan Masalah dan Self Efficacy Siswa Pengaruh Problem Based Learning Terhadap Kemampuan Pemecahan Masalah dan Self Efficacy Siswa Kelas VIII SMP Negeri 1 Patikraja*.

Tawfik, A. A. (2015). Essential Readings in Problem-Based Learning: Exploring and Extending the Legacy of Howard S. Barrows. *Interdisciplinary Journal of Problem-Based Learning*, *9*(2). https://doi.org/10.7771/1541-5015.1593

Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. In *Health Professions Education* (Vol. 2, Issue 2, pp. 75–79). King Saud bin Abdulaziz University. https://doi.org/10.1016/j.hpe.2016.01.004

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