

The Application of Concept-Based Learning on the Mathematical Connection Skills of Slow Learners

1st Andawiyah, Robiatul

Department of Mathematics Education,
Faculty of Education

Universitas Syarif Hidayatullah Jakarta
Jakarta, Indonesia

rbtlandawiyah@gmail.com

2nd Suhyanto, Otong

Department of Mathematics Education,
Faculty of Education

Universitas Syarif Hidayatullah Jakarta
Jakarta, Indonesia

otong.suhyanto@uinjkt.ac.id

3rd Musyrifah, Eva

Department of Mathematics Education,
Faculty of Education

Universitas Syarif Hidayatullah Jakarta
Jakarta, Indonesia

eva.musyrifah@uinjkt.ac.id

Abstract— Slow learners often have difficulty understanding mathematical concepts and relating these concepts to other relevant situations. One important skill that needs to be developed is mathematical connection skills. This study aims to determine the mathematical connection skills of slow learners through the application of a concept-based learning model. This study aims to determine the mathematical connection ability of slow learners through the application of a concept-based learning model. This study uses the Single Subject Research method with an A-B-A design on eighth-grade students in junior high school. The data obtained were then analyzed using within-conditions analysis and between-conditions analysis. The results of the study show that the mathematical connection abilities of students before the intervention were in the low category, with an average score of 27, while during the intervention, the average score became 80, and after the intervention through the application of the concept-based model, the average score increased. These results indicate that the application of the Concept-Based Learning model can improve the mathematical connection abilities of slow learners and assist students with learning difficulties during the mathematics learning process.

Keywords— *mathematical connection skills, slow learners, concept-based learning, single subject research*

I. INTRODUCTION

Mathematics is a fundamental science that plays an important role not only in everyday life but also in the advancement of various fields of knowledge. Therefore, mathematics learning should not only focus on numeracy skills, but also on understanding concepts, the ability to connect ideas, and their application in various everyday situations. One important skill that must be developed in students is mathematical connection skills, as this skill must be

strengthened in secondary school. [1] Similarly, the NCTM (National Council of Teachers of Mathematics) emphasizes that mathematical abilities include problem solving, reasoning and proof, communication, connection, and representation.[2] Therefore, mathematical connection skills are an integral part of the mathematics learning process, as they provide a foundation for students in mathematics learning.

Mathematical connections refer to students' ability to connect various topics in mathematics, connect mathematical concepts with other fields of science, and apply them in everyday life to solve problems. [2] Connections in mathematics are the interrelationships between different concepts, both those originating from within mathematics (internal) and from outside (external).[3] Meanwhile internally, mathematical connections refer to the interrelationships between concepts in mathematics itself, while externally, these mathematical connections are closely related to other fields of science and their application in everyday life. [3] Therefore, mathematical connections are very important because they illustrate how concepts in mathematics are interrelated, both within mathematics itself and with other fields of science and everyday situations. By applying mathematical connections, students not only understand concepts separately, but are also able to see the interrelationships between concepts and use them to deal with various real-life situations.

Based on research conducted by Elisahaya and Adi Ihsan Imami on mathematical connection skills using three mathematical connection indicators, it was found that students only achieved 45.83% on the indicator of connecting one mathematical concept to another, 16.67% on the indicator of connecting one mathematical topic to another, and 37.5% on the indicator of connecting mathematics with everyday situations. All of these achievements were in the low category. Therefore, it can be concluded that the mathematical connection skills of junior high school students are still relatively low.[4] The limitations of students in connecting

mathematical concepts and applying them in everyday contexts indicate that the learning system that has been implemented so far has not been fully effective, particularly in developing student engagement and connecting material in mathematics.

In the learning process, each student has different skills in understanding the subject matter due to various factors, such as slow learners. Children with special needs are children who have characteristics and needs that are different from other normal children. These different characteristics include physical, mental, intellectual, social, and emotional differences. [5] A person is classified as mentally disabled if they have three indicators, namely general intellectual limitations or below-average intelligence, an inability to function socially or adaptively, and limitations in social or adaptive behaviour that occur during the growth period, i.e., up to the age of 18. [6]

Based on their level of intelligence, children with intellectual disabilities are classified into four groups: mild intellectual disability, which is someone with an IQ of 55-70; moderate intellectual disability, which is someone with an IQ of 40-55; (3) severe intellectual disability, which is someone with an IQ of 25-40; and profound intellectual disability, which is someone with an IQ of < 25. [7] Intellectual intelligence (IQ) is a basic term used to describe the nature of the mind, which encompasses several abilities, such as the ability to think abstractly, reason, solve problems, plan, and develop ideas. [8] Intellectual intelligence (IQ) is a basic term used to describe the nature of the mind that encompasses several abilities, such as the ability to think abstractly, reason, solve problems, plan, and develop ideas. [8] One of the reasons for students' lack of understanding is learning disabilities, which are disorders or difficulties that make it hard for students to learn effectively. [9]

According to the results of research by Raedik Desta Kusuma and Abdul Huda, which shows that the addition skills of students with intellectual disabilities can be improved using appropriate learning approaches. [10] One way to help students with intellectual disabilities learn is by applying the concept-based learning model for mathematical connection skills. This concept-based learning model is a learning model that emphasizes how students understand concepts that are interrelated with the material being taught. According to Erickson, the concept-based learning model is a learning method that involves teachers in using facts supplemented with concepts and generalizations, due to the influence of thinking in the learning process. [11] This learning model offers a specific method that encourages students to build their understanding in developing concepts based on their experiences while honing their ability to apply the concepts being studied. [12] By understanding this learning method, students not only understand the material, but also how these concepts function and are used in various situations.

Single Subject Research is closely related to behaviour modification, which is a scientific approach to understanding and changing individual behaviour to overcome behavioural problems. In the behaviour modification process, there are four

activities, including identifying problems, determining behaviour levels, providing intervention, and following up. Based on the results of this study by Marshel Muhammad Farhan, Dedi Mulia, and Sistriadini Alamsyah Sidik, there was an increase in the ability to recognize currency values among children with intellectual disabilities. There was a stable change in value in each session in baseline phase 1 (A_1), and there was a change in value with an upward trend in the intervention phase (B). Then, there was a stable change in value in baseline phase 2 (A_2) with an upward trend compared to baseline phase 1 (A_1). [13]

Based on this description, problems were found in the mathematical connection skills of slow learners, requiring an appropriate learning model to overcome them. One alternative that can be used is the Concept-Based Learning model in mathematics learning. To obtain a clearer description of the mathematical connection skills of students with intellectual disabilities, prioritizing objectivity in measurement and focusing on individual data as samples, the Single Subject Research method was used. This learning model for slow learners is customized to the skills of the students. Researchers analyze the initial skills of students through baselines, observation results, and teacher documentation, so that researchers understand the cognitive limitations, learning speed, and individual learning needs of slow learners.

II. METHOD

Research methods are essentially scientific ways of obtaining data for specific purposes and uses. [14] In this study, the method used was Single Subject Research. The Single Subject Research method uses behaviour modification, where variable measurements are taken on the same subject but under different conditions over a certain period. [15] The baseline condition is the condition in which the target behavior is measured before any intervention is given or in its natural state. Meanwhile, the intervention condition is the condition in which the target behaviour has been given an intervention and is measured under that condition. [15]

The subjects in this study were three junior high school students who were classified as slow learners based on their IQ test results when they were first admitted to the school. In determining the subjects in this study, the first stage was to interview mathematics teachers to identify students who were classified as slow learners based on their IQ test results. In conducting preliminary research, the researcher sought to obtain initial information about various issues or problems related to the research object, so that they could determine with certainty what problems or variables needed to be studied.

Design A-B-A has shown a causal relationship between the dependent variable and the independent variable. There are three stages to determine whether or not there is an effect from the treatment given to a subject, by comparing the measurement results before and after the treatment was given. [13] Therefore, this study began with the baseline condition (A_1), where slow learners were given a mathematical

connection skills instrument until the desired data was obtained. Next, in the intervention condition, students were given a concept-based learning model, which was followed by the administration of a mathematical connection skills instrument not only once but four times during the intervention condition. After that, in baseline condition 2 (A_2), students will again be given the mathematical connection skills instrument as many times as needed. After completing these three conditions, a conclusion will be drawn as to whether the concept-based learning model is effective in improving the mathematical connection skills of slow learners or not.

Data analysis is the final stage before drawing conclusions. In experimental research, descriptive statistical techniques are generally used to analyze data. Therefore, in single case studies, complex statistics are not used; instead, simple descriptive statistics are more commonly used. In data analysis using visual analysis methods, there are several things that researchers need to pay attention to, namely: the number of data points (scores) in each condition, the level of stability and change in data levels within a condition or between conditions, and the direction of change within conditions and between conditions. In this study, data were collected through audio, photos, and written documentation. These were used to describe learning activities during the intervention phase. Written documents in the form of written test sheets were used to determine changes in learning outcomes during the baseline phase and the intervention phase.

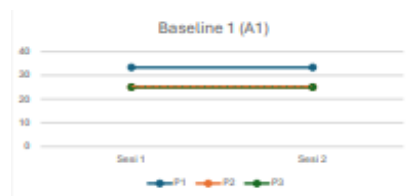
III. RESULTS AND DISCUSSION

RESULTS

This study was conducted face-to-face (offline) with junior high school students, specifically three students who were classified as slow learners. The study consisted of three conditions: baseline 1 (A_1), intervention (B), and baseline 2 (A_2). This study was conducted in 8 sessions, including two baseline 1 (A_1) sessions, 4 sessions for the intervention (B) condition, and 2 sessions for baseline 2 (A_2). The data from this study were obtained from mathematical connection ability tests consisting of 3 indicators given to the three slow learners in each session. Each session consisted of three questions covering the three indicators of students' mathematical connection abilities. The scope of the material in this study was linear equations and inequalities with one variable. The following are the results of the study for each condition:

A. Data Description

1. Baseline Condition 1 (A_1A_1)

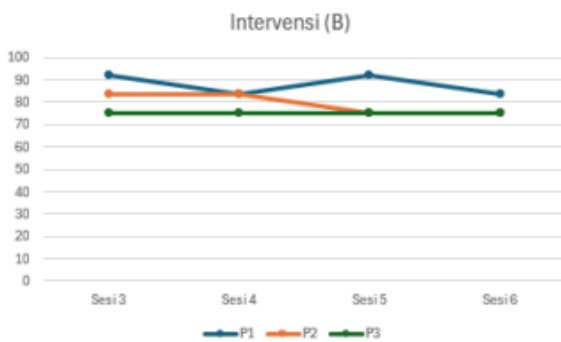


Graph 1 Baseline 1 (A_1)

Based on Graph 1, it shows that in session 1 subject P1 obtained the highest score compared to subjects P2 and P3. Subject P2 obtained the lowest score, while P3 obtained a higher score than P2 but still below P1. In session 2, P1 score decreased from the previous session, while the scores of P2 and P3 remained the same. The percentage of scores in session 1 shows that P1 obtained 33.33%, P2 obtained 25%, and P3 obtained 25%. Meanwhile, in session 2, P1 obtained 33.33%, P2 obtained 25%, and P3 obtained 25%. This shows that P1 consistently obtained higher scores than P2 and P3, even though there were similarities in the scores in sessions 1 and 2. Based on the classification of the descriptive analysis interpretation in the graph, the average percentage scores of P1, P2, and P3 were in the low category, indicating that the mathematical concept comprehension skills of the three subjects were still low and needed to be improved through further learning.

2. Intervention Conditions (B)

Intervention Conditions (B) The intervention in this study was the provision of student worksheets based on the Concept-Based Learning model, which was conducted over four sessions. The mathematical connection materials and instruments provided in sessions 3 and 4 were single-variable linear equations, while in sessions 5 and 6 they were single-variable linear inequalities. Data collection on mathematical connection skills scores in the intervention condition was conducted immediately after the use of the Concept-Based Learning model. The data on the percentage of mathematical connection skills scores for students with intellectual disabilities P1, P2, and P3. Visually, the percentage of mathematical connection skills scores for subjects P1, P2, and P3 are presented in the following graph

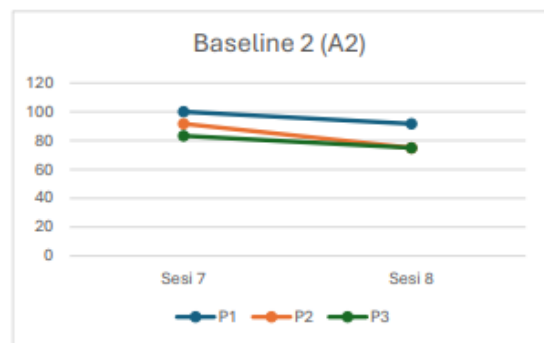


Graph 2 Intervention (B)

Based on the data in the graph, it shows that in sessions 3 to 6, subject P1 obtained higher scores than subjects P2 and P3 in each session. Subject P1 consistently showed an increase in ability to connect mathematical concepts, with a score percentage of 91.67% in sessions 3 and 5, while P2 scored 83.33% in sessions 3 and 4 and P3 scored 75% in sessions 3 to 6. In the following sessions, P2's scores tended to decline and P3 remained at the same score, while P1 maintained high results compared to the other subjects even though their scores fluctuated. Based on the descriptive analysis interpretation classification listed above, the average percentage score for P1 was in the excellent category, while P2 and P3 were in the good category. This shows that the mathematical concept comprehension skills of subject P1 were better than those of P2 and P3, although all three still needed assistance to achieve an optimal level of ability.

3. Baseline Condition 2 (A₂)

Baseline condition 2 (A₂) is the last condition in the Single Subject Research with an A-B-A design. This condition is carried out after the intervention has been completed. Baseline condition 2 (A₂) consisted of two sessions and used the same procedure as baseline condition 1 (A₁), in which students worked on three mathematical connection skills instrument questions in each session with a maximum duration of 60 minutes. The mathematical connection ability instrument material given in session 7 was single variable linear equations, and in session 8, it was single variable linear inequalities. Subject mathematical connection ability score percentage data

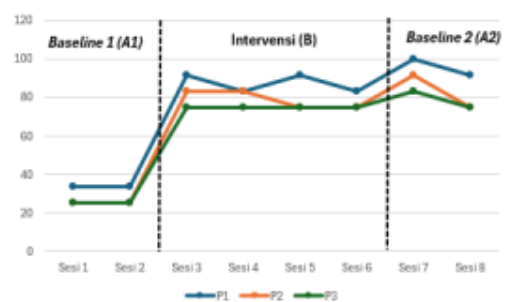


Graph 3 Baseline 2 (A₂)

Based on the graphs in sessions 7 and 8 (baseline 2), it shows that subject P1 still consistently obtained the highest score compared to subjects P2 and P3. In session 7, P1 obtained a score percentage of 100%, P2 obtained 91.67%, and P3 obtained 83.33%. Meanwhile, in session 8, P1 scored 91.67%, P2 scored 75%, and P3 scored 75%. This shows that in baseline phase 2, all three subjects experienced an increase in ability in session 7 compared to the previous session, with P1 continuing to show the most optimal results. This shows that in baseline 2, all three subjects showed an increase in mathematical connection skills, with P1 being the most stable and consistent subject in understanding and connecting mathematical concepts.

4. Data Acquisition Recapitulation

The following table shows a recapitulation of the percentage scores for mathematical connection abilities of subjects P1, P2, and P3 in baseline condition 1 (A₁), intervention (B), and baseline condition 2 (A₂). The percentage scores for mathematical connection skills of subjects P1, P2, and P3 are presented visually in the following graph:









Graph 4 Data Acquisition Recapitulation

The following table shows a recapitulation of the percentage scores for mathematical connection abilities of subjects P1, P2, and P3 in baseline condition 1 (A₁), intervention (B), and baseline condition 2 (A₂). The percentage scores for mathematical connection skills of subjects P1, P2, and P3 are presented visually in the following graph.

B. Analysis of Conditions







Single subject research with an A-B-A design consists of three conditions, namely baseline 1 (A₁), intervention (B), and baseline 2 (A₂). The analysis will be conducted on each of these conditions, covering the following components:

Table 1 Summary of Visual Analysis Results in Conditions of Mathematical Connection Skills P1

Subjects	Baseline 1 (A ₁)	Intervention (B)	Baseline 2 (A ₂)
Condition Length	2	4	2
Trend Direction			
	(Horizontal)	(Horizontal)	(Decreasing)
Kecenderungan Stabilitas	Stable (100%)	Stable (100%)	Stable (100%)
Jejak Data			
	(Horizontal)	(Horizontal)	(Decreasing)
Level Stabilitas dan Rentang	Stable (33.33%–33.33%)	Stable (83.33%–91.67%)	Stable (91.67%–100%)
Perubahan Level	Stable (33.33%–33.33%) (0%)	Stable (83.33% - 75%) (+8.33%)	Stable (100%–91.67%) (+8.33%)







Based on the table above, the length of the baseline 1 (A₁), intervention (B), and baseline 2 (A₂) phases consisted of 2, 4, and 2 sessions, respectively. The trend in phases A₁ and B showed a flat pattern, while phase A₂ showed a downward trend. All three phases showed data stability with a stability percentage of 100%. The data traces in phases A₁ and B show a flat pattern, while phase A₂ shows a downward pattern. The stability level in phase A₁ is in the range of 33.33%–33.33%, phase B in the range of 83.33%–91.67%, and phase A₂ in the range of 91.67%–100%, all of which are in the stable category. The level change in phase A₁ was 0%, in phase B it was +8.34%, and in phase A₂ it was +8.33%, indicating an increase in achievement during the intervention phase.

Table 2 Summary of Visual Analysis Results in Conditions of Mathematical Connection Skills P1

Subjects	Baseline 1 (A ₁)	Intervention (B)	Baseline 2 (A ₂)
Condition Length	2	4	2
Trend Direction			
	(Horizontal)	(Decreasing)	(Decreasing)
Kecenderungan Stabilitas	Stable (100%)	Stable (100%)	Stable (100%)
Jejak Data			
	(Horizontal)	(Decreasing)	(Decreasing)
Level Stabilitas dan Rentang	Stable (25% - 25%)	Stable (75% - 83,33%)	Stable (75% - 91,67%)
Perubahan Level	Stable (25% - 25%) (0%)	Stable (83,33% - 75%) (+8,33%)	Stable (91,67% - 75%) (+16,67%)

Based on the table above, the length of the baseline 1 (A₁), intervention (B), and baseline 2 (A₂) phases consists of 2, 4, and 2 sessions, respectively. The directional trend and data trace in phase A₁ show a flat pattern, while phases B and A₂ show a downward trend. All three phases show data stability with a stability percentage of 100%. The stability level in phase A₁ is in the range of 25% - 25%, phase B in the range of 75% - 83.33%, and phase A₂ in the range of 75%–91.67%, all of which are in the stable category. The level change in phase A₁ was 0%, in phase B it was +8.34%, and in phase A₂ it was +16.67%, indicating an increase in achievement during the intervention phase.

Table 3 Summary of Visual Analysis Results in Conditions of Mathematical Connection Skills P1

Subjects	Baseline 1 (A ₁)	Intervention (B)	Baseline 2 (A ₂)
Condition Length	2	4	2
Trend Direction			
	(Horizontal)	(Horizontal)	(Decreasing)
Kecenderungan Stabilitas	Stable (100%)	Stable (100%)	Stable (100%)
Jejak Data			
	(Horizontal)	(Horizontal)	(Decreasing)
Level Stabilitas dan Rentang	Stable (25% - 25%)	Stable (75% - 75%)	Stable (75% - 83,33%)
Perubahan Level	Stable (25% - 25%) (0%)	Stable (75% - 75%) (0%)	Stable (83,33% - 75%) (8,33%)

Based on the table, the length of the baseline 1 (A₁), intervention (B), and baseline 2 (A₂) phases consisted of 2, 4, and 2 sessions, respectively. The directional trend and data trace in phases A₁ and B showed a flat pattern, while phase A₂ showed a downward trend. All three phases showed data stability with a stability percentage of 100%. The stability level in phase A₁ is in the range of 25%–25%, phase B in the range of 75%–75%, and phase A₂ in the range of 75%–83.33%, all of which are in the stable category. The level change in phase A₁ was 0%, in phase B it was 0%, and in phase A₂ it was +8.33%, which indicates an increase in achievement during the intervention phase.

DISCUSSION

This study used the A-B-A Single Subject Research method by applying the Concept Based Learning model to the mathematical connection skills of slow learning students. Data collection in this study was divided into three conditions: first, baseline condition 1 (A₁); second, intervention condition (B); and third, baseline condition 2 (A₂). In general, the findings of this study reveal that mathematical connection skills in each condition have improved. The highest average score was found in baseline condition 2 (A₂). This finding means that the use of the Concept-Based Learning model can be considered effective in improving the mathematical connection skills of slow learners.

The starting point for this study was baseline 1, a condition in which no intervention had yet been given.[15] Baseline 1 was divided into two sessions, session 1 and session 2. At this stage, all three subjects still had relatively low scores for mathematical connection skills. However, P1 had a higher percentage score for mathematical connection skills than the other two subjects.

In line with the research conducted by Kunti Dian Ayu Afiani, Syarifuddin and Moch. Syakroni stated that the mathematical thinking skills of the two students were at a low level. This was because both students were unable to remember the facts or concepts of multiplication that they had learned. In addition, both students still had difficulty performing routine procedures or simple calculation processes in solving the multiplication problems given. Meanwhile, one subject has mathematical thinking skills at a moderate level. This is because the student can represent problems/information well and is able to make connections between mathematical concepts and solve simple mathematical problems, namely when making connections between the concepts of addition and multiplication correctly, even though they were given a little guidance and direction from the teacher directly.

In the intervention condition, which is the second condition in the method used by the researcher, or condition B, the Concept-Based Learning model was implemented using student worksheets. The improvement in students' mathematical connection skills cannot be separated from the stages in this learning model. In line with the research by Luthfi Aldiansyah, the Concept-Based Learning model offers a specific method that can encourage students to construct their own understanding in developing concepts based on their experiences while honing their ability to apply concepts. Thus, this learning model is one alternative for improving students' mathematical thinking processes.

In intervention condition (B), LKPD began to be used before administering a mathematical connection ability test containing three questions from each indicator. Students began to be able to model and solve single-variable linear equations and inequalities, although there were still errors in writing inequality signs or calculations. P1 was more capable of working on the questions given by the researcher regarding modeling linear equations and inequalities with one variable, as seen from the intervention scores. P2 and P3 were able to model linear equations and inequalities with one variable, although there were some errors.

In line with the research by Zahrina Salsabila and Dian Permatasari, the stability trend in the baseline phase (A) shows stability but with scores that are still in the low category, while in the intervention phase (B) it shows stability with a percentage of 75% for the baseline phase and 100% for the intervention phase. The data path in the baseline phase is flat. Meanwhile, the intervention phase shows an increase. The stability level in the baseline phase (A) shows stability in the range of 30–30,

while in the intervention phase (B), the results are stable in the range of 90–100. The change in level in the baseline phase (A) occurred in the range of 30–30, which was 0, while in the intervention phase (B), it occurred in the range of 90–100, which was +10. [17]

Specifically, the results showed that subject P1 was able to demonstrate a significant improvement in mathematical connection skills in each condition. Subject P1 showed good ability in understanding and connecting mathematical concepts and solving problems based on the relationships between concepts. Meanwhile, subject P2 also showed consistent improvement in each condition. This subject was more careful and took a little longer to solve the problems but appeared to be trying to understand each step of the solution. Subject P2 showed a significant improvement during the intervention phase and was able to maintain these results at baseline 2. Subject P3 also experienced an improvement in mathematical connection skills from the beginning to the end of the study. Initially, this subject seemed to have difficulty understanding the relationships between mathematical concepts, but after learning with the Concept-Based Learning model, he began to be able to build simple relationships between concepts. P3 was also active in asking questions when encountering difficulties and tried to find appropriate solutions.

Overall, the improvement in mathematical connection skills in these three mentally disabled subjects was due to the characteristics of Concept-Based Learning, which focuses on understanding the meaning and relationships between concepts, rather than just procedures. This reinforces Juang Sunanto's opinion that the effectiveness of an intervention in the Single Subject Research method can be seen from the consistent differences between the baseline and intervention conditions. Therefore, the results of this study indicate that the Concept-Based Learning model is effective in improving the mathematical connection skills of students with intellectual disabilities, as it helps them understand the interrelationships between concepts in depth, think more purposefully, and apply mathematical concepts in real life.

IV. CONCLUSIONS

This study used the Single Subject Research (SSR) A–B–A design to determine the effectiveness of the Concept-Based Learning model on the mathematical connection abilities of slow learners. Data collection was conducted through three conditions, namely baseline 1 (A_1), intervention (B), and baseline 2 (A_2). Based on the results of the study and discussion, in general, the conclusion of this study is that the use of the Concept-based Learning model can effectively improve mathematical connection skills. In general, the results showed that all three subjects experienced an increase in mathematical connection skills in each condition, with the highest average score at baseline 2 (A_2). This proves that Concept-Based Learning is effective in mathematics learning for slow learners.

At baseline 1 or before the implementation of the Concept-Based Learning model, all three subjects still showed low mathematical connection skills, although P1 had a higher score than P2 and P3. Before the implementation of the Concept-Based Learning model, the mathematical connection skills of all three subjects were still in the poor category. These initial conditions indicate that all three subjects had low mathematical connection skills before the intervention.

Under intervention conditions (B) or during the implementation of Concept-Based Learning, the gradual application of the model helped students build, connect, and apply mathematical concepts. Students begin to be able to create models of linear equations and inequalities with one variable, although there are still minor errors. P1 shows the best skills, followed by P2 and P3. The improvement in skills in each subject is influenced by the characteristics of Concept-Based Learning, which emphasizes understanding the meaning and relationships between concepts, rather than procedural memorization.

After the Concept-Based Learning model was discontinued and learning returned to the second baseline condition, the mathematical connection abilities of the three subjects continued to show improvement and remained at a higher level than before the intervention. P1 was able to maintain excellent improvement in connecting concepts, relating mathematical concepts to other fields, and applying them in everyday life. P2 also showed stable abilities at a good level. The same was true for P3, whose mathematical connection skills remained in the good category and did not decline after the intervention ended. Overall, the post-intervention results showed that concept-based learning had a sustained positive impact on all three subjects.

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