IMPLEMENTATION OF MICROSOFT MATHEMATICS ASSISTED KNISLEY LEARNING TO IMPROVE MATHEMATICAL REASONING

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Abstract: *This study aims to improve students' mathematical reasoning abilities on the subject of matrices through the application of the Knisley Mathematics Learning Model (MPMK) assisted by Microsoft Mathematics software. This study is a Classroom Action Research (CAR) which was carried out in two cycles. The subjects of the study were 30 students of class XI-IA 2 of SMA Negeri 6 Padangsidimpuan, consisting of 14 male students and 16 female students. Data were collected through mathematical reasoning ability tests and observations of student and teacher activities. The results of the study showed that the application of this model succeeded in significantly improving students' mathematical reasoning abilities, indicated by an increase in classical completeness from 46.67% in Cycle I to 86.67% in Cycle II, with an increase of 40%. In addition, student learning activities also increased from 63.71% to 81.03% (an increase of 17.32%), and teachers' ability to manage learning increased from 78.76% to 98.87% (an increase of 20.11%). Thus, it can be concluded that the Knisley Learning Model assisted by Microsoft Mathematics is effective in improving mathematical reasoning abilities, student activities, and teacher performance in matrix learning.*

Keywords: *Mathematical Reasoning Ability, Knisley Learning Model (MPMK), Microsoft Mathematics, Matrices*

Introduction

Mathematics is a compulsory subject in the Indonesian national education curriculum. Aligned with this, the National Council of Teachers of Mathematics (NCTM, 2000) outlines five standards for the goals of mathematics education, namely process standards and content standards. The process standards for mathematics education goals are problem-solving, reasoning and proof, communication, connections, and representation. These abilities will be valuable assets for students in the future. Mathematics and reasoning are two interrelated contexts, where reasoning can be trained through mathematics learning activities (Asoraya & Ruli, 2023; Cahya & Warmi, 2019; Julaeha & Kadarisma, 2020). Reasoning ability is the thinking process involved in drawing conclusions (Asoraya & Ruli, 2023; Nabila, 2023). This ability encompasses not only the mastery of computational procedures but, more importantly, the capacity to understand relationships between concepts, draw logical conclusions, construct valid arguments, and solve problems systematically.

Preliminary observations in class XI-IA 2 at SMA Negeri 6 Padangsidimpuan reveal a concerning issue: 70% of students struggle with mathematical reasoning, especially in matrices. This is likely due to a conventional, procedural teaching approach that prioritizes formula memorization over conceptual understanding. Consequently, students can solve routine problems but falter with non-routine tasks requiring higher-order reasoning.

Based on these problems, an innovation in learning models is required to create a learning environment that fosters the development of mathematical reasoning abilities. The Knisley Mathematics Learning Model (MPMK) offers a solution through its systematic learning phases, including exploration, concept introduction, application, and generalization. The Knisley Mathematics Learning Model (MPMK) is a learning model that encourages active student participation, indirectly lightens the student's learning load, and allows students to learn in an enjoyable atmosphere (Ashari, 2022; Pardede, 2021). This model is specifically designed to guide students in constructing mathematical knowledge through a structured reasoning process.

In the Industry 4.0 era, integrating technology like Microsoft Mathematics into math learning is essential. This free tool, accessible on computers and Android, facilitates conceptual understanding and accelerates computation, allowing students to focus on reasoning. It enables interactive visualization of matrices, verifies solutions, and explores different solving approaches. It also has a triangle solver and equation solver that provide step-by-step solutions for each problem, excellent features for learning to solve various mathematical problems (Mendezabal & Tindowen, 2018; Rabi et al., 2022; Sormin et al., 2023). Features like a graphing calculator and step-by-step equation solver make learning more varied and interesting, helping students master mathematical problem-solving.

The synergy between MPMK and Microsoft Mathematics is expected to create effective learning. MPMK provides a pedagogical framework that encourages the reasoning process, while Microsoft Mathematics provides a technological platform that facilitates in-depth mathematical exploration. Preliminary research indicates that a combination of innovative learning models and technological support can significantly improve mathematics learning outcomes (Maf'ulah et al., 2021; Nabila, 2023; Pardede, 2021; Rangkuti et al., 2022).

Based on the above explanation, the researcher conducted a study on the implementation of the Knisley Learning Model assisted by Microsoft Mathematics to improve students' mathematical reasoning abilities on matrix material. This research is expected to provide a real contribution to efforts to improve the quality of mathematics learning in schools.

Literature Reviewe

1. Mathematical Reasoning: A core standard in math education, defined as the process of drawing logical conclusions and constructing arguments. It extends beyond computation to conceptual understanding and systematic problem-solving, yet students often struggle with it under traditional, rote methods (Asoraya & Ruli, 2023).
2. Knisley Model (MPMK): An innovative pedagogical framework structured around exploration, concept introduction, application, and generalization. It actively engages students in knowledge construction, reduces cognitive load, and has been shown to improve learning outcomes (Ashari, 2022).
3. Microsoft Mathematics: A technological tool that functions as a graphing calculator and equation solver. It aids conceptual understanding through visualization and step-by-step solutions, allowing students to focus on reasoning over arithmetic (Mendezabal & Tindowen, 2018).

Synergy: Integrating MPMK with Microsoft Mathematics creates a powerful synergy. The model provides the pedagogical structure for deep reasoning, while the software offers a

platform for exploration and verification, together fostering a more effective and engaging learning environment.

Method

This research employs Classroom Action Research. The study was conducted in two cycles, with each cycle consisting of four main stages: planning, acting, observing, and reflecting (Suherman, 2022; Sukardi, 2022). The research takes place in Class XI-IA 2 at SMA Negeri 6 Padangsidimpuan. The study is carried out over a specific period covering the preparation process, the implementation of cycles I and II, and data analysis. The subjects of this research are all 30 students of Class XI-IA 2 at SMA Negeri 6 Padangsidimpuan, consisting of 14 male and 16 female students. The object of the research is the enhancement of students' mathematical reasoning ability through the implementation of the Knisley Mathematics Learning Model (MPMK) assisted by Microsoft Mathematics on the topic of matrices. Data collection techniques in this study include tests, observation, and instruments. The data analysis techniques used are Quantitative Data Analysis and Qualitative Data Analysis (Purnomo, 2011; Sukardi, 2022).

Study's success is determined by three indicators:

1. Improvement in students' mathematical reasoning, evidenced by at least 75% of students achieving the minimum mastery score (KKM) of 75.
2. An increase in student learning activity, reaching a minimum of 80% on the student observation sheet.
3. Enhanced teacher performance, achieving a minimum of 80% on the teacher performance observation sheet through the implementation of the Knisley Mathematics Learning Model (KMLM).

Result and Discussion

Research Results Description

1. Description of Classroom Action Research Results for Cycle I

Cycle I involved teaching the topic of Matrices using the Knisley Mathematics Learning Model (MPMK) in class XI-IA 2 of SMA Negeri 6 Padangsidimpuan. Cycle I was conducted over three meetings, with each meeting lasting 2 lesson periods (2 x 45 minutes). It consisted of four stages: planning, implementation, observation, and reflection. The results of the Cycle I research are elaborated as follows:

a. Results of Students' Mathematical Reasoning Ability Test in Cycle I

Cycle I applied the Knisley Model to improve mathematical reasoning on Matrices. The results showed that out of 30 students, only 14 (46.67%) passed the final test, while 16 (53.33%) did not meet the passing criteria. This indicates the students' reasoning ability remains low.

Table 4.1 Frequency Distribution of Students' Mathematical Reasoning Test in Cycle I

No.	Interval	Number of Students	Percentage	Criteria
1	77-84	2	6.67%	Very Good
2	69-76	17	56.66%	Good
3	61-68	3	10%	Fair
4	53-60	6	20%	Poor
5	45-52	2	6.67%	Very Poor
Total		**30**	**100%**	

The test results show that student mastery has not been achieved. Only 14 out of 30 students (46.67%) passed the minimum score of 75. This falls short of the ≥75% classical

success criterion. The majority of students were in the "Good" category, but a significant 26.67% were in "Poor" or "Very Poor." Therefore, reflection and improvement are needed for the next cycle.

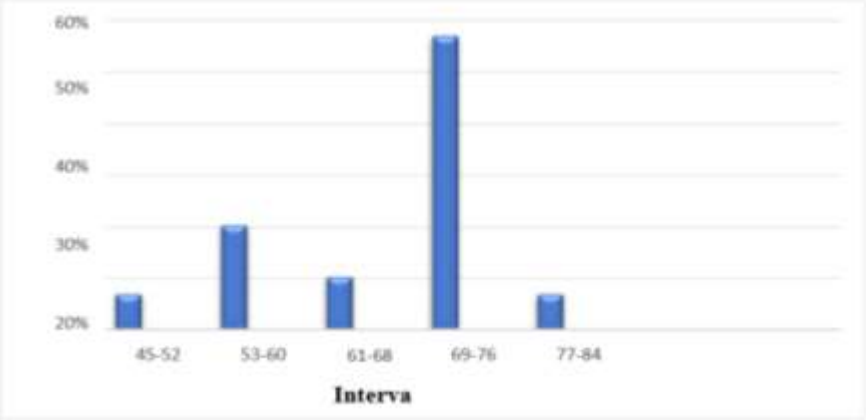

Diagram 4.1 would be here, showing a bar chart of the percentage distribution across criteria

The results show students' mathematical reasoning ability is only 46.67%, failing to meet the 75% target. Therefore, more effective learning activities must be designed for the next cycle.

b. Results of Student Activity Observation in Cycle I

Observation is an integral part of the data collection process in this research. The researcher acted as an observer, monitoring all student activities in the classroom during the intervention. The results of observations on student activities across the 3 meetings are as follows:

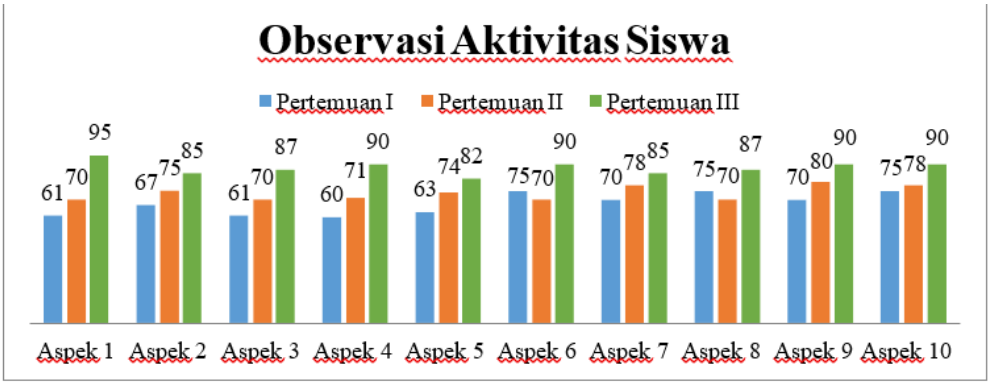

Diagram 4.2 would be here, likely a line or bar graph showing the percentage for each observed aspect across the 3 meetings

Student activity observation using the MPMK model yielded 63.71%, which is below the 80% target, requiring the research to proceed to the next cycle.

c. Results of Teacher Performance Observation in Cycle I

Observation was also conducted on the teacher's performance in managing the learning process. The results are presented in the table below:

Table 4.2 Results of Teacher Performance Observation in Cycle I

No.	Assessment Aspect	Meeting Score			Average	Percentage
		I	II	III	Score	(%)
1	**Lesson Opening Skills**					
	a. Orientation conducted	3	4	3	3.33	83.25
	b. Apperception conducted	3	3	3	3.00	75.00
	c. Motivating students	3	4	3	3.33	83.25
	d. Providing references	3	3	3	3.00	75.00
2	**Material Presentation**					
	a. Mastering the subject matter	3	3	3	3.00	75.00
	b. Clear and systematic presentation	3	4	4	3.67	91.75
3	**Learning Strategy**					
	a. Applying the MPMK model	3	4	3	3.33	83.25
	b. Systematic use of learning	3	4	3	3.33	83.25
4	**Utilization of Learning Media**					
	a. Availability of media/aids	3	3	3	3.00	75.00
	b. Suitability of media to material	3	3	3	3.00	75.00
	c. Skill in using media	3	4	3	3.33	83.25
5	**Classroom Management**					
	a. Disciplining students	3	3	3	3.00	75.00
	b. Involving students	3	4	3	3.33	83.25
	c. Arranging the physical classroom	3	3	3	3.00	75.00
6	**Learning Assessment**					
	a. Process Assessment	3	3	3	3.00	75.00
	b. Final Assessment	3	4	3	3.33	83.25
7	**Lesson Closing Skills**					
	a. Summarizing the material	3	4	3	3.33	83.25
	b. Giving assignments	3	3	3	3.00	75.00
	c. Informing the next material	3	3	3	3.00	75.00
8	**Efficient Use of Time**					
	a. Punctuality in starting lesson	3	3	3	3.00	75.00
	b. Punctuality in presentation & evaluation	3	3	3	3.00	75.00
	c. Punctuality in ending lesson	3	3	3	3.00	75.00
Total		**66**	**75**	**67**	**69.31**	**1732.75**
Average					**3.42**	**78.76%**
Qualification					**Good**	

From Table 4.2, the observation of teacher performance using the MPMK in Cycle I shows an average percentage of 78.76%. As the target for teacher performance in this research is ≥ 80%, it is concluded that the research must continue as it has not yet met the success indicator.

d. Reflection

Reflection shows the Knisley Model's initial implementation was unsuccessful. Students' mathematical reasoning was low (46.67%), and their activities did not meet the target (63.7%). Teacher performance also fell short of the goal (78.76%). All indicators were below the 80% success threshold, indicating a need for improvement in the subsequent cycle.

Table 4.3 Reflection for Cycle I

Problem	Solution
Lack of variety in solving problems.	Guide students to work on problems without fear of making mistakes.
Lack of student confidence in their own answers.	Motivate students to work on tests individually.
Learning comprehension is not yet universal.	Explain the material by connecting it to everyday life.
Lack of student courage to ask and answer questions.	Motivate and guide students to ask and answer questions, starting with general or easy questions.

The researcher concludes that Cycle I was unsuccessful, as student reasoning, student activity, and teacher performance all fell below the targets. Therefore, the research will proceed to Cycle II, where actions will be taken to address the shortcomings identified in this reflection.

2. Description of Classroom Action Research Results Cycle II

The actions in Cycle II were a follow-up to the reflection results from Cycle I. In Cycle II, modifications were made to the learning media and improvements to the learning tools. The activities of Cycle II were carried out in three meetings. Each meeting lasted for 2 lesson hours (2 x 45 minutes) in Class XI-IA 2 of SMA Negeri 6 Padangsidimpuan. The results of the actions in Cycle II are described as follows:

a. Results of Students' Mathematical Reasoning Ability Test Cycle II

In Cycle II, the Knisley Model was reapplied to improve mathematical reasoning on matrices. A test at the end of the cycle showed significant improvement. The overall percentage score for students' mathematical reasoning ability was calculated at 86.67%, successfully exceeding the 80% success indicator. This result demonstrates a substantial increase from Cycle I and confirms the model's effectiveness in the second iteration.

Table 4.4 Frequency Distribution of Students' Mathematical Reasoning Test Cycle II

No	Interval	Number of Students	Percentage	Category
1	90-95	7	23.3%	Very Good
2	84-89	6	20%	Good
3	78-83	8	26.7%	Fair
4	72-77	7	23.3%	Poor
5	66-71	2	6.7%	Very Poor
Total		**30**	**100%**	

The test results show significant improvement. 86.67% of students (26 out of 30) achieved at least a "Fair" score, surpassing the 75% success target. The score distribution was: 23.33% "Very Good," 20% "Good," 26.7% "Fair," 23.37% "Poor," and 6.7% "Very Poor." This indicates that students' mastery of the material has met the success criteria and marks clear progress compared to Cycle I.

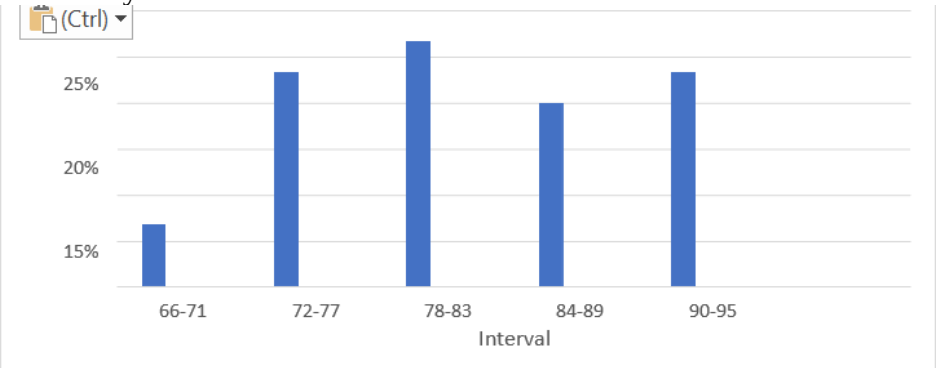

Diagram 4.3 Percentage Results of Students' Mathematical Reasoning Test Cycle II

In Cycle II, students' mathematical reasoning ability successfully achieved the target of ≥75%. The result was 86.67%, showing significant improvement from the previous cycle. This indicates that the learning enhancements were effective and successfully met the expected criteria.

b. Results of Student Activity Observation Cycle II

The results of observations on student activities during learning over 3 meetings in Cycle II, obtained the following results:

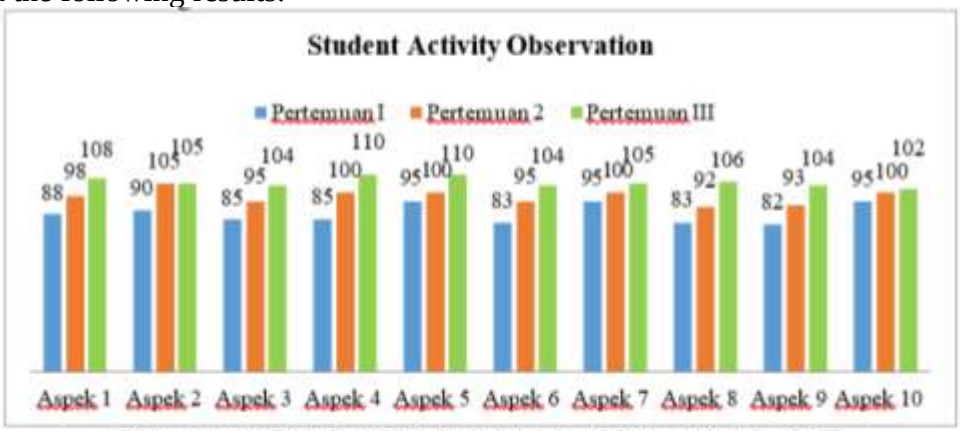

Diagram 4.4 Results of Student Activity Observation Cycle II

Student activity observation with the Knisley Model achieved an average of 81.03%, successfully meeting the ≥80% target. Therefore, the research is concluded as it has achieved its desired criteria. This improvement is hoped to be maintained for a better learning process.

c. Results of Teacher Performance Observation Cycle II

The results of observations on teacher performance during learning over 3 meetings can be seen in the following table:

Table 4.5 Results of Teacher Performance Observation Cycle II

No	Assessment Aspect	Score for Meeting			Average	Percentage (%)
		I	II	III		
1	**Skills in Starting the Lesson**					
	a. Orientation conducted	4	4	4	4	100
	b. Apperception conducted	4	4	4	4	100
	c. Apperception conducted	4	4	4	4	100
	d. Providing references	4	4	4	4	100
2	**Material Presentation**					
	a. Mastering the subject matter	4	4	4	4	100
	b. Clear and systematic presentation	4	4	4	4	100
3	**Learning Strategy**					
	a. Applying brainstorming method	4	4	4	4	100
	b. Systematic learning used	4	4	4	4	100
4	**Utilization of Learning Media**					
	a. Availability of media/tools	3	4	4	3,67	91,75
	b. Suitability of media with material	4	4	4	4	100
	c. Skill in using media	4	4	4	4	100
5	**Classroom Management**					
	a. Disciplining students	3	4	4	3,67	91,75
	b. Involving students	4	4	4	4	100
	c. Arranging the physical classroom	4	4	4	4	100
6	**Learning Assessment**					
	a. Process Assessment	4	4	4	4	100
	b. Final Assessment	4	4	4	4	100
7	**Skills in Closing the Lesson**					
	a. Summarizing the material	4	4	4	4	100
	b. Giving assignments	4	4	4	4	100
	c. Informing the next material	4	4	4	4	100
8	**Efficient Use of Time**					
	a. Punctuality in starting the lesson	4	4	4	4	100
	b. Punctuality in presentation & evaluation	4	4	4	4	100
	c. Punctuality in ending the lesson	3	4	4	3,67	91,75
Total		**85**	**88**	**88**	**87,01**	**2175,25**
Average					**3,95**	**98,87%**
Criteria		**Very Good**				

The observation of teacher performance in Cycle II achieved an average of 98.87%, significantly surpassing the 80% target. Therefore, the research was concluded and not continued.

d. Reflection

Based on the reflection of Cycle II, the implementation of the Knisley Mathematics Learning Model (MPMK) was highly successful, meeting and exceeding all predetermined success indicators. Consequently, the research is concluded and will not be continued into further cycles.

The students' mathematical reasoning ability test achieved an excellent result of 86.67%, surpassing the 75% target. This improvement was characterized by students using varied problem-solving strategies and demonstrating greater confidence in their answers.

Furthermore, observations confirmed that both student activities and teacher performance successfully met the targets. Student activity reached 81.03% (against an 80% target), showing significant active participation. Most notably, teacher performance achieved a near-perfect score of 98.87%, far exceeding the 80% requirement. All assessed aspects showed substantial improvement, confirming the model's effectiveness and the conclusion of the research.

B. Discussion of Research Results

1. Improvement in Students' Mathematical Reasoning Ability Test Results

Viewed from the results of the students' mathematical reasoning test, after the action in Cycle I consisting of 3 meetings and a test given to 30 students at the end of the meeting, it was found that students obtained an average score of 68.8 with a completion percentage of 46.67% or 14 students passed. Because Cycle I did not meet the set success indicator of ≥75%, the learning continued to Cycle II.

After completing the learning in Cycle II, students were given a test again. The results showed an improvement from Cycle I to Cycle II. In Cycle II, the average score increased to 82 with a completion percentage of 86.67% or 26 students passing. Thus, the increase in students' mathematical reasoning test results was 40%. For clarity, the improvement in students' mathematics test results can be seen in the following diagram:

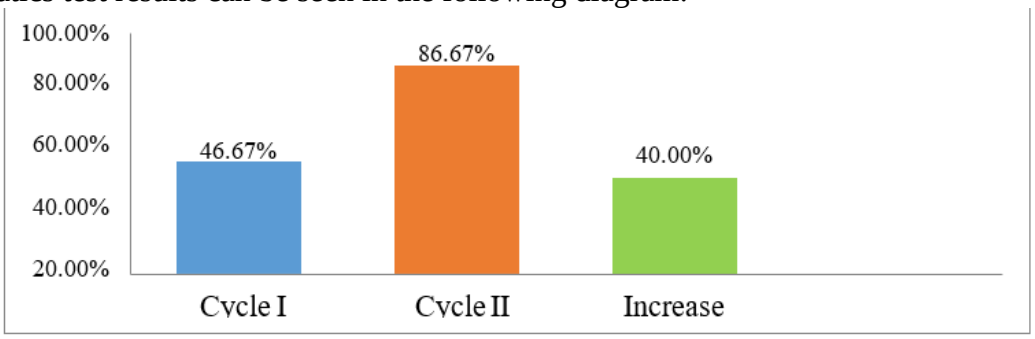

Diagram 4.5 Increase in Percentage Results of Students' Mathematical Reasoning Test from Cycle I to Cycle II

2. Improvement in Student Activity Observation

Observation of student activity showed an average of 63.71% in Cycle I, as students were unfamiliar with the Knisley Model (MPMK). This increased to 81.03% in Cycle II, a 17.32% rise, successfully meeting the ≥80% success indicator.

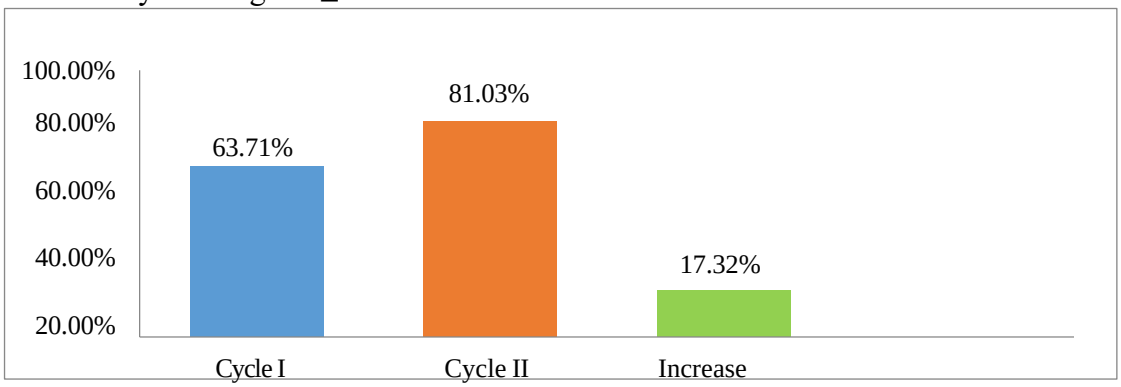

Diagram 4.6 Increase in Results of Student Activity Observation from Cycle I to Cycle II

3. Improvement in Teacher Performance Observation Results

The observation of teacher performance in Cycle I showed an average of 78.76%, indicating that the implementation of the Knisley Model still required improvement. Consequently, the research proceeded to Cycle II. The results significantly improved, with the average teacher performance reaching 98.87%. This 20.11% increase successfully exceeded the success indicator of ≥80%, demonstrating a highly effective enhancement in the teacher's ability to manage the learning process.

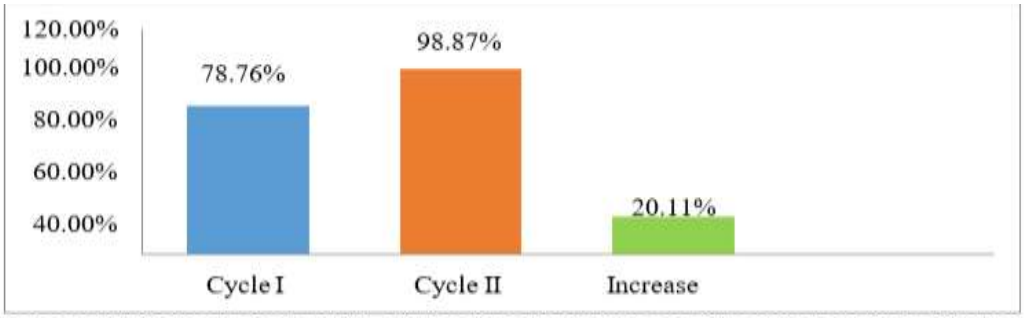

Diagram 4.7 Increase in Results of Teacher Performance Observation from Cycle I to Cycle II

C. Research Limitations

The research conducted in Class XI-IA 2 of SMA Negeri 6 Padangsidimpuan regarding the Knisley Mathematics Learning Model (MPMK) as an effort to improve students' mathematical reasoning ability has limitations. The limitations in this research include the lack of students' understanding of basic mathematical concepts, so the researcher had to first touch upon other related mathematics topics connected to the matrix material. This reduced the time originally allocated for learning the matrix material. Another limitation was the time allotted by the school, which led the researcher to limit this research to the main subject matter being taught.

Conclusion

Based on the objectives, results, and discussion of the research conducted at SMA Negeri 6 Padangsidimpuan, it can be concluded that:

1. There was an improvement in students' mathematical reasoning ability through the use of the Knisley Mathematics Learning Model (MPMK).
2. There was an increase in students' mathematics learning activities after the implementation of the mathematics learning model.
3. There was an improvement in the teacher's performance in mathematics learning through the implementation of the Knisley Mathematics Learning Model (MPMK).

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