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IMPROVING STUDENTS' MATHEMATICAL REASONING THROUGH THE LEARNING CYCLE INSTRUCTIONAL MODEL

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ABSTRACT Mathematical reasoning is an essential skill that every student must possess as a tool to find problem-solving solutions effectively and efficiently, develop cognitive abilities, and foster critical and creative thinking in facing 21st-century challenges. However, students' mathematical reasoning skills remain low, particularly in solving and analyzing complex mathematical problems. This issue arises due to students' passive involvement in the learning process. This study aims to improve the mathematical reasoning skills of eighth-grade students through the implementation of the Learning Cycle instructional model. The research method used is Classroom Action Research (CAR). The results indicate that the average score of students' mathematical reasoning tests increased from 22.96 in the initial test to 47.85 in Cycle I and 80.64 in Cycle II. Additionally, the percentage of students meeting the mathematical reasoning competency criteria increased from 8% in the initial test to 19% in Cycle I and reached 75% in Cycle II. Based on the findings, it can be concluded that the implementation of the Learning Cycle instructional model is effective in enhancing students' mathematical reasoning skills in the topic of Probability in eighth grade. This model can serve as an alternative instructional strategy to increase student engagement and understanding in mathematics.

Keywords: mathematical reasoning, learning cycle, mathematics learning, classroom action research

ABSTRAK Penalaran matematis merupakan salah satu kemampuan yang harus dimiliki setiap siswa sebagai alat untuk menemukan solusi masalah secara efektif dan efisien, mengembangkan kemampuan kognitif, serta menumbuhkan sikap kritis dan kreatif dalam menghadapi tantangan abad ke-21. Namun, kemampuan penalaran matematis siswa masih rendah, terutama dalam menyelesaikan dan menganalisis permasalahan matematika yang kompleks. Hal ini terjadi karena siswa masih pasif dalam proses pembelajaran. Penelitian ini bertujuan untuk meningkatkan kemampuan penalaran matematis siswa kelas VIII melalui penerapan model pembelajaran Learning Cycle. Metode penelitian yang digunakan adalah Penelitian Tindakan Kelas (PTK). Hasil penelitian menunjukkan bahwa rata-rata skor tes kemampuan penalaran matematis siswa meningkat dari 22,96 pada tes awal menjadi 47,85 pada siklus I dan 80,64 pada siklus II. Selain itu, persentase ketercapaian kemampuan

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penalaran matematis secara klasikal meningkat dari 8% pada tes awal menjadi 19% pada siklus I dan mencapai 75% pada siklus II. Berdasarkan hasil penelitian, dapat disimpulkan bahwa penerapan model pembelajaran Learning Cycle efektif dalam meningkatkan kemampuan penalaran matematis siswa pada materi Peluang di kelas VIII. Model ini dapat digunakan sebagai alternatif strategi pembelajaran untuk meningkatkan keterlibatan aktif siswa dan pemahaman mereka dalam matematika.

Keywords: penalaran matematis, learning cycle, pembelajaran matematika, penelitian tindakan kelas

INTRODUCTION

According to the National Education System Law No. 20 of 2003, education is a conscious and planned effort to create a learning atmosphere and process that enables students to actively develop their potential. This includes fostering spiritual and religious strength, self-control, personality, intelligence, noble character, and the essential skills required by individuals, society, the nation, and the state (Gusteti & Neviyarni, 2020). In the 21st century, students are required to possess 21st-century skills, which include the 4C skills—critical thinking, communication, collaboration, and creativity. One of these essential skills is mathematical reasoning, which serves as a crucial tool for students to develop effective and efficient problem-solving strategies, enhance cognitive abilities, and cultivate critical thinking and creativity in addressing modern challenges (Suryonegoro et al., 2024). By strengthening mathematical reasoning skills, students are expected to be more competitive in the global workforce and capable of adapting to rapid technological advancements.

Education is considered an effective means of shaping positive character in the younger generation (students). This aligns with the National Education System Law (Sisdiknas) No. 20 of 2003, particularly Article 1, Paragraph (1), which emphasizes the importance of education in character development as part of national development. According to Dianti (2014), character education should begin by instilling an understanding of good and bad behavior, which should then be applied in individuals' attitudes and actions (Humaeroh & Dewi, 2021). Character education not only plays a role in shaping students' personalities but also serves as a catalyst for developing other skills that can be nurtured through the learning process at school. Learning activities, as interactions between teachers and students, aim to develop students' intellectual, emotional, and moral maturity. The success of learning largely depends on the relationship between teachers and students, as well as the presence of various supporting components in the teaching and learning process to create an effective learning environment (Jayanti & Brier, 2020)

Survey results The 2022 Program for International Student Assessment (PISA) shows that ability reading and mathematics student 15 years old experience decline since 2015 to now (Alam, 2023). The results of the PISA survey show low ability reasoning mathematical student caused by several factor . One of the factor the causes include because students in Indonesia are less trained in solving contextual problems,

demanding reasoning, argumentation and creativity in solving them, where these questions are the characteristics of TIMS questions. This is in accordance with the Ministry of Education and Culture (2013) which states that the low achievement of Indonesian students is caused by the large number of test materials in TIMS that are not included in the Indonesian curriculum (Hastuti, & Babo, 2021).

In line with this, Ma'arif et al (2020) stated that reasoning and problem-solving abilities are two important abilities and are the main focus to be developed and possessed by students through mathematics learning in schools. These two abilities are closely related to each other, because to solve a mathematical problem must involve reasoning which is complex thinking such as analytical thinking, critical thinking, and creative thinking (Hastuti, Rosleny Babo, 2021). Reasoning ability and mathematical material are two things that cannot be separated. Mathematical material can be understood through reasoning, and reasoning can be trained through mathematics (Akuba et al., 2020). Thus, mathematical reasoning ability is very important and needed in learning mathematics (Rahmawati & Astuti, 2022). According to Zebua & Mendrofa (2023) ability reasoning mathematical is ability the main thing that needs to be done mastered student specifically in solve problem , interesting conclusion and understanding context learning mathematics in words complex . Through election strategies and approaches special expected capable increase ability reasoning mathematical students so that later student will the more critical in analyze , synthesize as well as to describe draft the learning that is taught.

Based on interviews conducted with 3 mathematics teachers at UPT SMP Negeri 1 Mare, it was found that at the school, especially in the subject lesson mathematics student not enough involved active during the learning process ongoing . The implications mark results Study student especially on the material opportunity No achieve KKM. This is happen because the teacher is still use method demonstration without give example cases that can completed by students so that student not enough skillful in finish questions and do reasoning mathematical will draft opportunities provided by teachers. Beside that , the teacher is lacking give chance to student For do presumption beginning so that student difficulty in interesting conclusion end . Even though in fact one of Indicators of mathematical reasoning in mathematics learning include the stages of proposing conjectures, carrying out mathematical manipulations, drawing conclusions and checking the validity of an argument.

To address the issues found in schools, solutions are needed to maximize the learning process. According to Febrianti et al. (2023), the effectiveness of the learning process can be enhanced through the selection of innovative teaching strategies, ensuring that students' learning activities become more optimal. One possible solution is the implementation of an instructional model that aligns with the subject matter, ensuring that it positively impacts students' mathematical

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reasoning skills. Consequently, students will also become more actively engaged in mathematics learning.

One of the external factors influencing students' progress and success in learning mathematics is the instructional model used (Marpaung, 2020). Therefore, mathematics instruction should be delivered using varied models that suit the characteristics of the subject matter. One such model that can be implemented is the Learning Cycle, a student-centered instructional approach (Budiman et al., 2019). The Learning Cycle model aims to enhance students' engagement and motivation throughout the learning process. This model consists of several phases, namely assignment, exploration, explanation, elaboration, and evaluation, designed to help students develop a deeper understanding of mathematical concepts.

A study on the implementation of the Learning Cycle model was previously conducted by Gulo et al. (2024). The results of their research indicate that applying the Learning Cycle model in mathematics learning can enhance students' conceptual understanding. As a novelty in this study, the researcher further examines the implications of implementing this model on students' mathematical reasoning. This research is conducted with the objective of improving students' mathematical reasoning abilities in eighth-grade mathematics learning at UPT SMP Negeri 1 Mare.

METHODS

This study employs Classroom Action Research (CAR), which is a form of inquiry conducted through self-reflection. Classroom action research aims to improve teaching patterns, enhance student behavior, and refine learning practices to achieve better educational outcomes. The CAR design consists of four stages: planning, action, observation, and reflection. In the planning stage, the researcher prepares lesson plans (RPP), selects learning resources and media, and develops evaluation tools to assess the implementation of mathematics learning. The action stage involves applying the Learning Cycle model in the classroom, where the teacher conducts apperception, provides motivation, organizes students into groups, and assigns group tasks. In the observation stage, the researcher monitors students' mathematical reasoning skills, engagement in learning activities, and evaluates student performance. Finally, in the reflection stage, the researcher analyzes observation results from each cycle, evaluates the learning process, and makes necessary improvements for the next cycle.

This study was conducted at SMP Negeri 1 Mare, located in Mare Sub-district, Bone Regency, during the even semester of the 2023/2024 academic year. The population of this study consists of eighth-grade students, with Class VIII D selected as the sample through random sampling to represent the overall student population. The research began with an initial observation, followed by the implementation of two action cycles, each consisting of three meetings, and concluded with a reflection phase.

The instruments used in this study include observation sheets to assess the implementation of learning activities, student activity observation sheets to monitor engagement, student response questionnaires to measure students' interest in mathematics learning, and mathematical reasoning tests to evaluate students' conceptual understanding after receiving different treatments. These instruments were validated by two mathematics lecturers from the Mathematics Education Study Program at Muhammadiyah University of Bone, who confirmed their validity and reliability for application in the learning process.

The observation sheets on learning implementation and student activity were completed by observer teams during the implementation of the Learning Cycle model. The student response questionnaire consists of five answer choices: Strongly Agree (SS), Agree (S), Disagree (TS), and Strongly Disagree (STS). Mathematical reasoning test data were collected through post-test assessments after the application of the Learning Cycle model. The categorization of student responses follows the criteria in Table 1.

Table 1. Categorization of Student Responses

Percentage Range (%)	Category
0% ≤ x < 20%	Very Poor
21% ≤ x < 40%	Poor
41% ≤ x < 60%	Fair
61% ≤ x < 80%	Good
81% ≤ x ≤ 100%	Excellent

The data analysis technique used in this study follows quantitative descriptive analysis, referring to previously established evaluation interpretation criteria. The success indicator for this study is that at least 75% of students demonstrate improved mathematical reasoning skills (≥75%) after implementing the Learning Cycle model in eighth-grade mathematics learning at UPT SMP Negeri 1 Mare. The categorization of students' initial mathematical reasoning test scores is presented in Table 2.

Table 2. Student Initial Mathematical Reasoning Test Scores

Score Range	Category
89 ≤ N ≤ 100	Very High
79 ≤ N < 89	High
69 ≤ N < 79	Moderate
41 ≤ N < 69	Low
0 ≤ N < 41	Very Low

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FINDING AND DISCUSSION

After conducting a validity test instrument research, researcher do test ability beginning students. Test beginning This aiming For measure level knowledge student about material opportunities that will studied and for to form team learning that will used in learning models Learning Cycle. Score results from test ability beginning students who do before application of learning models Learning Cycle in learning mathematics about opportunity described in Table 1 below.

Table 3. Description of Test Results Ability Beginning Student

Statistics	Statistic value k
N	2 8
Mean	22.96
Minimum	0
Maximum	78
Sum	574

Based on table 3 which shows the distribution of initial ability scores of 28 students, the average score is 22.96. The lowest score obtained by students is 0, while the highest score reaches 78, with a total overall score of 574. When the students' initial ability scores are grouped into four categories, the results are shown in the frequency distribution table and percentage of students ' mathematical reasoning as follows:

Table 4. Acquisition Percentage Category Test Ability Beginning Student

No	Score	Criteria	Frequency	Percentage
1	$89 \leq N < 100$	Very high	-	0%
2	$79 \leq N < 88$	Tall	-	0%
3	$69 \leq N < 78$	Currently	2	7 %
4	$41 \leq N < 68$	Low	6	21 %
5	$0 \leq N < 40$	Very low	20	72 %

The data in table 2 shows that students' ability in learning mathematics is included in the very low category, reaching 72 %. The total number of students is 28 people , only 2 students or 7 % get scores in the medium category with a range of scores between 68 - 78. Students who get scores in the low category, namely between 40 - 68, are 6 students or 21 %, and students who get scores in the high and very high categories are 0%. If it is connected with the criteria for the completeness of the reasoning results mathematically , then the result The students' math tests yielded the frequency and percentage scores shown in the following table:

Table 5. Acquisition Percentage Category Test Ability Beginning Student

No	Score	Category	Frequency	Percentage
1	< 75	Not finished	26	93 %
2	≥ 75	Completed	2	7 %

Percentage of completion of ability Students' initial mathematics can be seen in the following diagram:

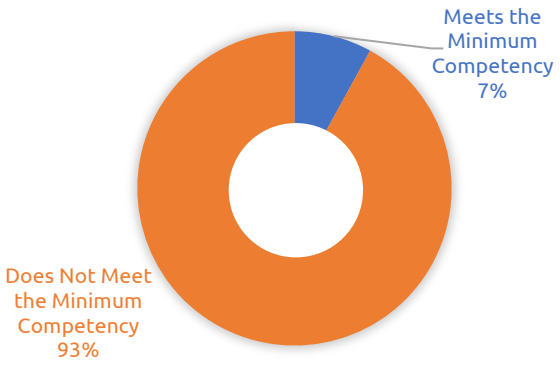

Figure 1. Capability Diagram Beginning Student

Research result in Cycle I

The results of the implementation observation assisted by the mathematics subject teacher from the observation in cycle I are summarized briefly that the average teacher activity in cycle I with the application of the Learning Cycle learning model is 4.70. With rounding, the value of 4.70 becomes 5. Therefore, the teacher's activity in cycle I is categorized as "fully implemented". Furthermore , the percentage of student activity in cycle I with the application of the Learning Cycle learning model as big as 71%. Based on the criteria for success, this student activity action is categorized as very good with a score interval of 60-80. The percentage of student responses in cycle I with the implementation of the Learning Cycle learning model was 84.9% Agree and 15.1% Disagree. According to the success criteria, student activities are included in the "very good" category with a score interval of 81-100.

During the implementation of the Learning Cycle learning model in cycle I, there were some progress and improvements achieved by students. However, there are still aspects that need to be improved and reorganized to improve the results in the next cycle. The improvements and developments achieved in cycle I include: The average teacher activity, based on observer observations, was 4.70, student responses to the Learning Cycle learning model reached an average of 84.9%, student activity showed 71% of students were active. Teacher activities are categorized as "fully implemented", student responses as "very good", and student activities as "very good". However, researchers still want to improve the results further, because some stages of teacher activity implementation have not been maximized and many students are still less active during the learning process.

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A number of aspect important things to do designed return namely at the stage implementation of the learning model Learning Cycle, students looks confused and lacking enthusiastic follow lessons. For overcome problem this, researcher will give motivation additional for students more motivated and active in the learning process. Next attitude student during learning Still need fixed. Some student No notice teacher's explanation with serious and less participate in activity group. Besides that, students often involved in conversation with Friend a group and less believe self-moment serve results discussion group them. For overcome problem this, the teacher will give time for a moment for class silence, then request disruptive students or make commotion for explain material lessons. The last thing that needs to be organized repeat is in the activity cover, part student Still difficult for make conclusion material that has been they learn. At the time assignment at the end lessons, some big students also do not so Serious do training given by the teacher. For overcome problem, the teacher helps student for make conclusion.

Next, the results test ability reasoning mathematical student during implementation cycle I is described as following.

Table 6. Description of Test Results Ability Mathematical Cycle I

Statistics	Statistic value k
N	28
Mean	47.85
Minimum	11
Maximum	89
Sum	1.292

Based on table 4, which shows the distribution of cycle I scores from 28 students, the average score is 47.85. The lowest score obtained is 11, while the highest score reaches 89, with a total overall score of 1,292. If the students' initial ability test scores are grouped into four categories, then the frequency distribution table and percentage of students' mathematical reasoning will be as follows:

Table 7. Acquisition Distribution Frequency Test Ability Reasoning Mathematical Student Cycle I

No	Score	Criteria	Frequency	Percentage
1	$89 \leq N < 100$	Very high	-	0%
2	$79 \leq N < 88$	Tall	3	10 %
3	$69 \leq N < 78$	Currently	2	7 %
4	$41 \leq N < 68$	Low	13	47 %
5	$0 \leq N < 40$	Very low	10	36 %

The data in table 5 shows that students' ability in learning mathematics is included in the very low category, reaching an average value of 47.85. The total number of students is 28 people, only 2 students or 7% get a score in the medium category with

a range of scores between 69 - 78. Students who get scores in the low category, namely between 41 - 68, are 13 students or 4 7 %, and students who get scores in the high category, namely 3 students or 1 0 % and very high as much as 0%. If associated with the criteria for the completion of the results of the reasoning ability test, then the results of the students' mathematical reasoning test obtained frequency and percentage scores as in the following table:

Table 8. Acquisition Percentage Category Test Dissemination Mathematical Cycle I

No	Score	Category	Frequency	Percentage
1	< 75	Not finished	2 3	82 %
2	≥ 75	Completed	5	18 %

Mathematical reasoning completion in Cycle I can be seen in the following diagram:

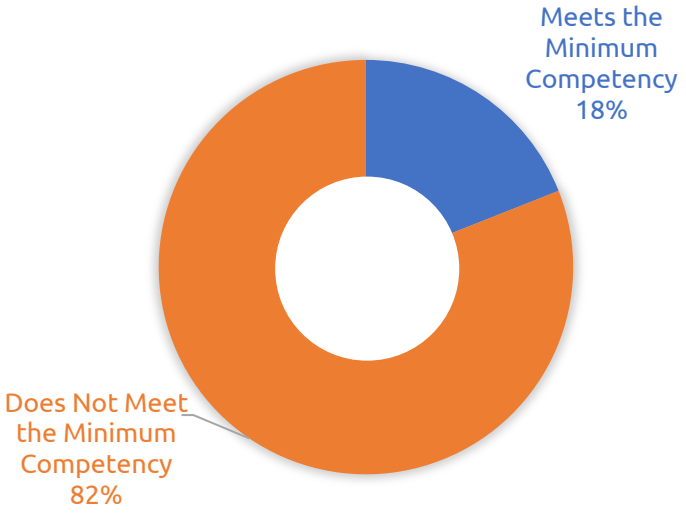

Figure 2. Cycle I Diagram

The percentage of mathematical reasoning in the cycle I test showed that 1.8 % of students managed to achieve completeness, while 8.2 % of students did not achieved completeness. Although there was an increase after the implementation of the Learning Cycle learning model in class VIII D of SMP Negeri 1 Mare in cycle I, the results still did not achieve completeness. Therefore, the researcher decided to continue the research to cycle II.

Research result in Cycle II

The average teacher activity in cycle II with application of learning models Learning Cycle is 4.8%. With rounding, the value of 4.8% becomes 5. With Thus, teacher activities in cycle II are categorized as “implemented” all in all”. Percentage activity students in cycle II with application of learning models Learning Cycle 92%. Based on criteria success action activity student This classified as category very Good with a score interval of 80-100. Furthermore, the percentage response students in cycle II with application of learning models Learning Cycle 85.1% Agree and 14.9% Disagree

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agree. Based on criteria success action activity student This classified as category Good very with a score interval of 80-100.

In implementation Cycle II, researchers and teachers conducted reflection on the learning process that occurred in class VIII D UPT SMP Negeri 1 Mare. Based on observer observation, teacher activities with application of learning models Learning Cycle gained an average of 4.8%, while response student reached an average of 85.1%. In addition that, 92% of students involved active in activities. With results mentioned, teacher activities are categorized as "implemented" all in all ", response student as " good" once ", and activities student as " very Good ".

Next, the results test ability reasoning mathematical student during implementation cycle II is described as following.

Table 9. Description of Test Results Ability Mathematical Cycle II

Statistics	Statistic value k
N	28
Mean	80.64
Minimum	55
Maximum	100
Sum	2.258

Based on Table 7, the distribution of reasoning ability results in scores of 28 students shows that the average score is 80.64. The lowest score obtained by students is 55, while the highest score reaches 100, with a total overall score of 2,258. If the students' reasoning ability test scores are grouped into four categories, then the frequency and percentage distribution table is as follows:

Table 10. Acquisition Distribution Frequency Test Ability Reasoning Mathematical Student Cycle II

No	Score	Criteria	Frequency	Percentage
1	$89 \leq N < 100$	Very high	13	46%
2	$79 \leq N < 88$	Tall	0	0%
3	$69 \leq N < 78$	Currently	8	29%
4	$41 \leq N < 68$	Low	7	25%
5	$0 \leq N < 40$	Very low	0	0%

The data in table 8 shows that students' abilities in cycle II mathematics learning have improved. experience improvement and included in the Very High category, reaching a percentage of 46%. The total number of students is 28 people, only 7 students or 2.5 % get a score in the low category with a value range between 41 – 68. Students who obtained values in the medium category, namely between 69 – 78, were 8 students or 2.9 % , and No There is students who get mark in category high

and low once. If referring to the criteria for the completion of the reasoning ability test results, then the frequency score and percentage of students' mathematical reasoning test results can be seen in the following table:

Table 11. Acquisition Percentage Category Test Dissemination Mathematical Cycle II

No	Score	Category	Frequency	Percentage
1	< 75	Not finished	7	25%
2	≥ 75	Completed	21	75%

Mathematical reasoning completion in Cycle II can be seen in the following diagram:

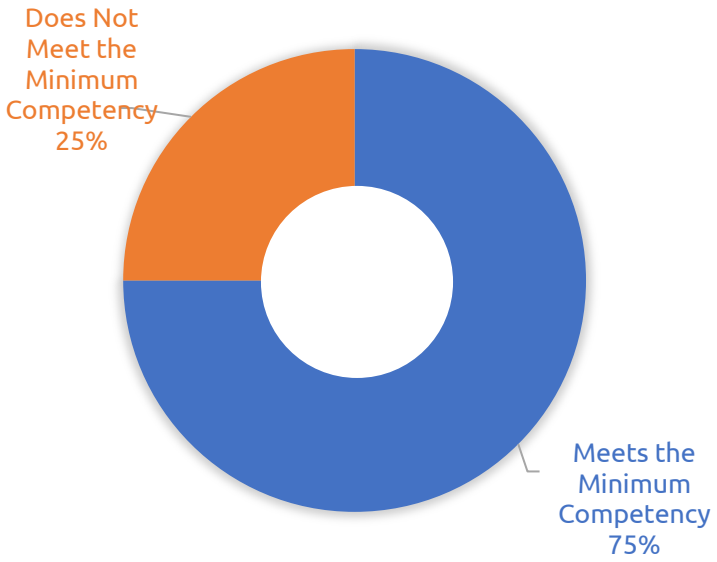

Figure 3. Cycle II Diagram

Percentage completeness ability reasoning mathematically in cycle II shows that 75% of students reach completion, while 25% of students do not yet reach completion. This result shows that the application of learning models in the Learning Cycle in cycle II has been completed reach level adequate completion. Therefore that, the researcher stop continue research in cycle II.

This research is a Classroom Action Research (CAR) using the Learning Cycle learning model. The purpose of this study is to improve students' mathematical reasoning skills. This research was conducted in class VIII D UPT SMP Negeri 1 Mare and is divided into two cycles. Each cycle consists of two meetings for the learning process and one meeting for evaluation at the end of the cycle. This study aims to observe students' activities during mathematics learning using the Learning Cycle learning model and to evaluate students' mathematical reasoning abilities in the same context.

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The learning cycle learning model is a model concept that emphasizes direct experience and the provision of reflection or drawing conclusions so that there is a deeper understanding of the concept. This is the reason why the application of this learning cycle model has positive implications for improving students' mathematical reasoning. As stated by Muk'adzin et al (2024) that indicators of mathematical reasoning in mathematics learning include the stages of submitting conjectures, carrying out mathematical manipulations, drawing conclusions and checking the validity of an argument. The integration of deep understanding encourages students to explore and recognize the concepts of the material being taught. After understanding this concept, students will apply their understanding in solving more complex mathematical problems. Therefore, the stages of the learning cycle model are very effective in improving students' mathematical reasoning abilities.

Learning Cycle learning model showed significant progress after improvements were made from cycle I. This model has achieved classical completeness, which indicates an increase in students' mathematical reasoning abilities on the topic of probability in class VIII D UPT SMP Negeri 1 Mare. This finding is in line with the results of research by Syarah Ilhamsyah et al (2021), which shows that the implementation of the Learning Cycle model can increase teacher and student activities . Increase activity This also has implications for increasing ability reasoning mathematical students. Beside That communication established between teachers and students become supplies success implementation study this. Communication interwoven mathematics give convenience for student for finish problem enough math complex. Through teacher guidance, interaction with Friend peers and earnings relevant information become support student in increase ability reasoning mathematics (Emida et al., 2024).

In general comprehensive application of the learning cycle model in learning mathematics proven capable increase activity student in the learning process, able to convincing student will understanding them and able increase reasoning mathematically. This is proven in cycle I, students who initially Still hesitant in give presumption beginning will the problems they face break it down slow later start develop ability analysis and thinking critical so that they capable describe draft beginning. Then with encouragement from the teacher, seen in cycle II students Already capable in reflect method they think and compose the strategy they use use in improve the settlement process problem mathematics. This is what causes the occurrence improvement reasoning mathematical student as depicted in Diagram 4 below.

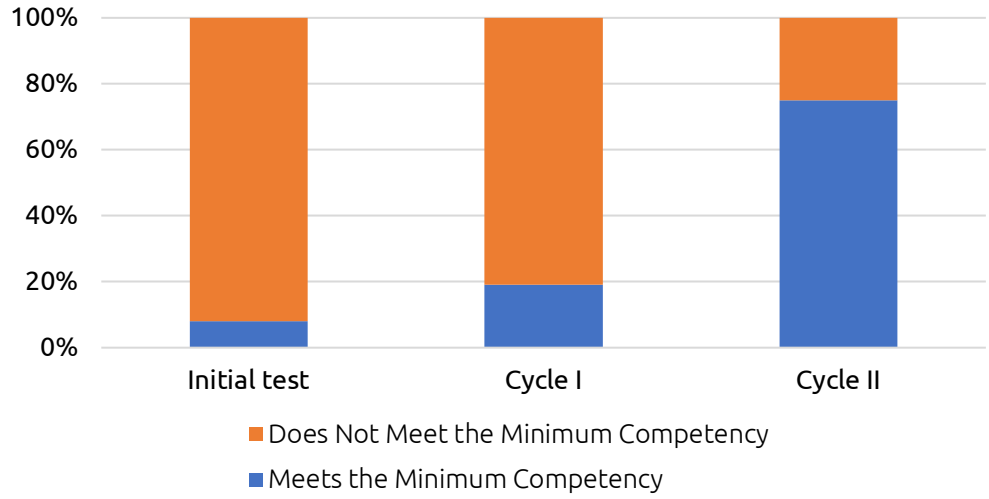

Figure 4. Implementation Diagram Learning

Based on Figure 4, it can be concluded that the implementation of the Learning Cycle learning model effectively improves students' mathematical reasoning abilities. This improvement can be seen from the observation sheet, where the presence and activeness of students during the learning process show progress at each meeting. In addition, the analysis of student scores shows an increase in the average score starting from the initial test, cycle I, to cycle II after the implementation of the Learning Cycle learning model. These results are in line with Annisa's (2022) view that the Learning Cycle model can improve learning activities, learning outcomes, and have a positive impact on students specifically in improvement ability reasoning mathematically.

CONCLUSIONS AND RECOMMENDATIONS

Based on the research findings and discussion, it can be concluded that the Learning Cycle model effectively enhances students' mathematical reasoning abilities in learning mathematics, particularly on the topic of Probability in Class VIII D at UPT SMP Negeri 1 Mare. The Learning Cycle model provides a structured learning process that facilitates student exploration, concept introduction, and application of understanding, enabling students to develop reasoning skills more easily. Through this model, students can form initial assumptions and draw conclusions based on the material presented by the teacher. The results indicate that students' mathematical reasoning indicators have been successfully achieved in line with the effective implementation of the Learning Cycle model syntax.

Following the research and analysis, the researcher provides several recommendations. In teaching subject matter, especially mathematics, teachers should not rely solely on one teaching strategy to improve student competencies. Instead, they should consider utilizing various instructional strategies, including the Learning Cycle model, to make learning more effective. For future researchers

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interested in the Learning Cycle model, it is recommended to expand the study by incorporating other variables to explore improvements in additional skills, particularly in mathematics learning. This research also has practical implications, demonstrating that the application of the Learning Cycle model can serve as an alternative instructional strategy for teachers to enhance students' mathematical reasoning skills, especially in Probability learning.

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