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Experimentation of Learning Cycle 7E Assisted by Labyrinth Board Game and Putar Bawah Game on Mathematical Reasoning Ability in View of Students' Self-Regulated Learning

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Abstract

The purpose of this study is to determine which of the following: 1) the learning model that improves students' ability to reason mathematically—the Learning Cycle 7E (LC 7E) supported by the labyrinth board game, the putar bawah game, or direct instruction; 2) the degree of students' self-regulated learning that improves students' ability to reason mathematically—high, moderate, or low levels of Self-Regulated Learning (SRL); and 3) the relationship between learning models and students' SRL. This study used eighth grade students from JHS 5 Surakarta in the academic year 2022–2023 as its topic. It is a quasi-experimental study. Two classes selected via cluster random sampling are used in the samples. Tests, questionnaires, and documentation were the methods utilised to collect data. A two-way variance analysis with 2x3 uneven cells was employed in the data analysis technique. The analysis's conclusions were as follows: 1) Students with high levels of self-regulated learning outperformed those with low levels; 2) There was no relationship between the learning model and SRL; and 3) The LC 7E learning model, with the help of the labyrinth board game and the putar bawah game, produced better mathematical reasoning ability than direct instruction.

Keywords: Learning Cycle 7E (LC 7E) assisted by labyrinth board game and putar bawah game; mathematical reasoning ability; Self-Regulated Learning (SRL)

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INTRODUCTION

Since mathematics is one of the subjects that must be studied at all educational levels, it is evident that mathematics plays a significant role in the field of education. Universal knowledge in mathematics serves as the cornerstone for the advancement of contemporary technology and contributes significantly to the advancement of human thought (Marliani & Puspitasari, 2022). Since mathematics is an endeavour to help students think critically, logically, analytically, systematically, artistically, and collaboratively, it should be taught to all students, from elementary school through college (Abror, 2022).

Students need to possess the following five mathematical power process requirements, according to the National Council of Teachers of Mathematics, or NCTM (2000: 29): (1) Problem solving; (2) Reasoning; (3) Communication; (4) Connections:

(5) Illustrations. According to NCTM's mathematics learning standards, mastering mathematical reasoning is crucial for students' success in mathematics. The process of mathematical reasoning involves applying concepts, procedures, and pertinent facts or data to draw conclusions (Berg, D. H., 2018). According to Gultom & Roesdiana (2019),

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mathematical reasoning is a high-level thinking skill that involves the capacity to reason rationally and methodically in order to draw conclusions from supporting data and sources. This reasoning skill is highly useful in analysing novel situations, beginning with the explanation of ideas, moving on to evidence, and culminating in the generation of fresh conclusions. It can assist students in assessing their knowledge (Morsanyi, M., Prado, J., & Richland, 2018). Students that possess sound mathematical reasoning habits are not only capable of comprehending mathematical concepts, but also of applying what they have learned in the classroom.

Despite ongoing efforts, there's still a concern about Indonesian students' mathematical reasoning abilities. Results from the 2018 PISA survey paint a concerning picture. Among 79 participating countries, Indonesia ranked 73rd with an average score of 379 (Masfufah & Afriansyah, 2021). This suggests that Indonesian students' mathematical reasoning skills are not yet at an optimal level. It's important to note that PISA assessments emphasize higher-order thinking skills, which include mathematical reasoning (Hadi, 2022).

The low mathematical reasoning ability of students is also reinforced by the results of observations carried out at JHS 5 Surakarta showing that out of 6 classes obtained student learning outcomes reach KKM only 12.5% because students' mathematical reasoning skills are not optimal. In learning activities are still dominated by the teacher and less involve students in discussion activities and cooperation. So it seems that the teacher only provides knowledge to students without any feedback in the process. Reasoning skills will be obtained well if students and teachers establish a close communication relationship during learning (Barnes, 2019). Therefore, an appropriate teaching method is needed and actively involves students in the learning process, one of which is by applying the Learning Cycle 7E type cooperative learning model assisted by the learning media of the labyrinth board game and putar bawah game.

The Learning Cycle 7E learning model is one of the learning models based on the constructivism approach where in the learning process students are required to build their own knowledge based on experience so that learning activities are more determined by students. The implementation of Learning Cycle 7E in learning places the teacher as a facilitator who manages the Learning Cycle 7E learning phases. The phases of the Learning Cycle 7E learning model include Elicit, Engagment, Exploration, Explaination, Elaboration, Evaluation, and Extend (Annisa 2022). In the elicit and engage phases, the teacher helps students to recall prerequisite material and build initial understanding related to the material to be learned. In this phase, the turn down game is used to help build students' initial understanding of the material to be learned. Suardana, Redhana, Sudiatmika, & Selamat (2018) stated that prior knowledge can help students to build new knowledge. Prior knowledge makes students ready to learn and combine prior knowledge with learning materials. In the explore phase, students are given a putar bawah game media accompanied by student worksheet, where students are required to be actively involved and work together in a group to find problem solving on student worksheet by utilizing the media provided. Through discussion activities, students will get used to exchanging ideas and experiences with their friends (Siregar, Risnawati & Nurdin, 2018). In the explain phase, students are invited to explain concepts using their own sentences, so that students can explain and interpret the concepts they have obtained. Then, in the elaborate, evaluate and extend phases, students are guided to apply the concepts that have been obtained to new situations, evaluate and connect the concepts that have been obtained with other concepts.

Students are also given a labyrinth board game that contains practice problems, where students' efforts in solving these practice problems can train their mathematical reasoning skills. In addition, students must be creative and innovate to develop strategies in order to win the labyrinth board game. Thus, students can learn mathematics meaningfully because students are not only directed to just listen, record, then memorize, but students are invited to actively think, communicate, search and process data, until finally they can conclude and apply it.

Beyond teachers and teaching methods, student success also depends on their ability to self-regulate their learning. Currently, with a heavy course load of 6 subjects per semester and limited classroom time (typically 4 lessons a week), students can't solely rely on what they learn in class. To excel, they need to take initiative and learn independently. Self-regulated learning equips students with the characteristics needed to improve their mathematical reasoning skills. It empowers them to consciously plan, execute, and evaluate their learning process, fostering independence and responsibility. By taking charge of their learning, students are better positioned to strengthen their mathematical reasoning abilities.

Motivated by the potential of the Learning Cycle 7E model to improve students' mathematical reasoning skills, and recognizing the additional influence of self-regulated learning, this study investigates the following: " Experimentation of Learning Cycle 7E Assisted by Labyrinth Board Game and Putar Bawah Game on Mathematical Reasoning Ability in View of Students' Self-Regulated Learning."

RESEARCH METHOD

This study, conducted at JHS 5 Surakarta, employs a quantitative reserch. Due to the inability to control all influencing variables except for the independent variable, a quasi-experimental method is adopted. The design utilized is a quasi-experiment with a posttest-only control design, employing a simple factorial design of 2x3. The aim is to examine the impact of two independent variables on the dependent variable. These independent variables consist of the learning model—specifically, the Learning Cycle 7E model with assistance from the labyrinth board game and the putar bawah game, alongside the direct instruction model—and students' self-regulated learning, categorized as high, moderate, and low. The dependent variable under scrutiny is the mathematical reasoning ability.

The sampling technique used in this study was cluster random sampling. In this study, each class VIII of JHS 5 Surakarta is a sub-population or cluster. Of the eight classes, two classes were taken randomly with the assumption that there was no school policy in grouping students so that the conditions of each class were almost the same. In addition, there is also no superior class or in other words, all classes are regular. In this study, the samples will be grouped into two and given different treatments, namely the experimental group is given treatment using the LC 7E learning model assisted by the learning media of the labyrinth board game & putar bawah game, while the control group is given treatment with a direct instruction model. The samples in this study were class VIIIF students as the experimental class and class VIIIE students as the control class.

This study employs three data collection methods: documentation, testing, and questionnaires. The documentation method involves gathering existing data from documents (Budiyono, 2017). In this research, it was utilized to obtain data from the Even Midterm Test results in mathematics, serving as initial data to assess the equivalence between the experimental and control groups prior to experimentation.

The testing method was employed to gather data on students' mathematical reasoning abilities. Additionally, the questionnaire method was utilized to collect data on students' self-regulated learning.

The mathematical reasoning ability test utilized in this study comprises four questions presented as descriptions, covering all indicators of mathematical reasoning ability. Before implementation, these questions underwent content validity testing to ensure their appropriateness for research purposes. The validation process was conducted by Ira Kurniawati, S.Si., M.Pd., a Mathematics Education Lecturer at FKIP UNS, and Sri Yuswati, S.Pd., a Mathematics Teacher at JHS 5 Surakarta. Following the content validity test, all four items were deemed to meet the required criteria and were deemed suitable for testing. The test instrument was administered to class VIIIG students at JHS 5 Surakarta to assess the quality of the questions. An analysis was then conducted to evaluate differentiation and difficulty levels to ensure question reliability. Items were considered to have good differentiation if the differentiation index (D) was ≥ 0.3. After calculation, it was determined that all four items exhibited good differentiation as their differentiation index (D) were ≥ 0.3.

After the differentiation test is carried out, proceed with measuring the level of difficulty of the items. Good items are items that are not too easy and not too difficult. Questions with a satisfactory level of difficulty fall within the range of $0.30 \leq P \leq 0.70$. Through the computation of the difficulty index for the mathematical reasoning ability test, it's evident that all four items fall within this range, indicating a moderate level of difficulty. Therefore, all items are deemed to meet the criteria for good difficulty levels. Upon assessing the differentiation index and difficulty level of the items in the mathematical reasoning ability test, all items have met the criteria for satisfactory differentiation and difficulty, making them suitable for use. Among the four items that fulfill these criteria, a reliability test, denoted as r_{11}, was conducted. The calculated reliability coefficient for the selected four items is 0.7178. Since an instrument is considered reliable if its reliability coefficient (r_{11}) is ≥ 0.7, the mathematical reasoning ability test instrument proves to be reliable and can be utilized to gather data on mathematical reasoning ability.

The researcher has developed a self-regulated learning questionnaire for students, comprising 40 statement items structured in a Likert scale format. Each item offers four response options: always (S), often (SR), rarely (J), and never (TP). Ira Kurniawati, S.Si., M.Pd., a Mathematics Education Lecturer at FKIP UNS, and Sri Yuswati, S.Pd., a Mathematics Teacher at JHS 5 Surakarta, served as validators for the self-regulated learning questionnaire. Following their evaluation, all 40 items were deemed suitable for research based on the established criteria for questionnaire review. The questionnaire was then administered to class VIIIG students at JHS 5 Surakarta for testing.

Then proceed with the internal consistency test using the Karl Pearson formula. Questionnaire items are said to have good internal consistency and are suitable for use if $rxy \geq 0{,}3$. Based on the calculation of the internal consistency index of the questionnaire items, the results show that out of 40 questionnaire items, 32 questionnaire items have a good internal consistency index, while the other 8 are inconsistent because of the consistency index $rxy < 0{,}3$.

The questionnaire instrument with 32 selected questionnaire items that have a good internal consistency index is then calculated the reliability coefficient (r_{11}) with the Alpha formula. The instrument is said to be reliable if $r_{11} \geq 0{,}70$. From the calculation, the reliability coefficient for 32 questionnaire items is 0.8525 or 0.8525. r_{11}

> 0,70. Therefore, the questionnaire instrument that has been prepared by the researcher is reliable and can be used to collect data on students' self-regulated learning.

Before commencing experiments on both samples, an equilibrium test was initially conducted utilizing a t-test to ascertain whether the populations shared similar initial conditions. Prior to conducting the average equilibrium test on each sample, a prerequisite test was conducted, namely the normality test and the homogeneity test.

He normality test's objective was to determine whether the samples extracted originated from populations with normal distribution or not. The normality test employed the Liliefors method with a significance level of 0.05. The results of the initial state normality test obtained that in the experimental class resulted in a value of Lhitung = 0,1163 and $L_{tabel} =$ 0,1566. While for the control class produces values $L_{hitung} =$ 0,1038 and $L_{tabel} =$ 0,1591. The obtained results showed that the value of L_{hitung} for each class does not exceed L_{hitung}. Thus, the conclusion that can be drawn is H_0 not rejected, meaning that each sample comes from a normally distributed population.

Following the normality test, the homogeneity test was conducted on both the experimental and control classes utilizing the Bartlett method with the Chi-Square test statistic and a significance level of 0.05. According to the homogeneity test results, the initial conditions of both classes yielded a calculated value of $X^2_{hitung} =$ 0,0579 Ï DK = { X^2 | X^2 > X^2_{tabel}} with $X^2_{tabel} =$ 3,8415. So that the decision is obtained H_0 not rejected. Therefore, it was concluded that both the experimental and control classes originated from homogeneous populations.

The average equilibrium test was carried out to determine whether the initial conditions of the two populations were balanced or not. The test statistic employed was the t-test with a significance level of 0.05. Based on the average equilibrium test results, the initial conditions of both the experimental and control classes yielded a calculated value of t = 0,5248 less than t_0,025;61 = 1,9996. Therefore t = 0,5248 ÏDK then H_0 is not rejected. This means that the experimental and control classes have the same initial ability.

The data analysis technique utilized was a two-way analysis of variance with unequal cells, followed by a post-analysis test employing the Scheffe method. As a prerequisite for analysis, it was ensured that the population exhibited normal distribution using the Liliefors test and possessed equal variance (homogeneity) using the Bartlett method.

RESULTS AND DISCUSSION

Self-Regulated Learning Data

The scores for students' self-regulated learning questionnaires are derived from the summation of scores from each questionnaire item. The categorization of self-regulated learning into high, moderate, and low is determined based on the mean self-regulated learning score across all samples and the standard deviation of all samples. From the self-regulated learning questionnaire data, the mean self-regulated learning score for the entire sample ($\bar{X}$) = 92.9206 and the standard deviation of all samples (s) = 10.7265.

The indicator for grouping the level of self-regulated learning used is if $X \geq \bar{X} + s^1 \ or \ X \ \geq$ 103,6471 is a high category, $\bar{X} - s^1 < X < \bar{X} + s^1 \ or$ 82,1942 $< X^2 <$ 103, 6471 is a moderate category.

According to the self-regulated learning questionnaire data, in the experimental class, there were 7 students classified in the high self-regulated learning category, 19 students in the moderate category, and 6 students in the low category. In the control class, 8 students were classified as high, 16 as moderate, and 7 as low in self-regulated learning.

Mathematical Reasoning Ability Data

The mathematical reasoning ability test used in this study contains random material. The scores obtained from the mathematical reasoning ability test were categorized based on the learning model and students' self-regulated learning.
The data indicate that the class utilizing the Learning Cycle 7E model assisted by the labyrinth board game and the putar bawah game demonstrated higher highest, lowest, median, and average scores compared to the class utilizing the direct instruction model. This discrepancy suggests that students exposed to the Learning Cycle 7E model, with assistance from the labyrinth board game and the putar bawah game, exhibit superior mathematical reasoning skills compared to those taught with the direct instruction model.

Furthermore, in both the class using the Learning Cycle 7E model with labyrinth board game and putar bawah game assistance, and the class using the direct instruction model, students with high self-regulated learning outperformed those with moderate and low self-regulated learning. Additionally, students with moderate self-regulated learning demonstrated better results than those with low self-regulated learning. This indicates that students with high self-regulated learning exhibit superior mathematical reasoning ability compared to those with moderate and low self-regulated learning, while students with moderate self-regulated learning outperform those with low self-regulated learning.

Prerequisite Test Analysis

The normality test was carried out utilizing the Liliefors method with a significance level of 0.05. Results of the normality test revealed that in the experimental class, the calculated value was $L_{hitung} = 0{,}1452$ and $L_{tabel} = 0{,}1566$. While for the control class produces values $L_{hitung} = 0{,}1143$ and $L_{tabel} = 0{,}1591$. In the column normality test results obtained that at a high level of self-regulated learning produces values of $L_{hitung} = 0{,}2084$ and Ltabel = 0,2288, for the moderate level of self-regulated learning produces values $L_{hitung} = 0{,}1396$ and $L_{tabel} = 0{,}1498$, while for the low self-regulated learning level produces values Lhitung = 0,1521 and $L_{tabel} = 0{,}2457$. Based on the obtained results from both row and column normality tests, it is evident that the calculated L_{hitung} for each group of learning models and self-regulated learning level does not exceed L_{tabel} or L_{hitung} ÏDK so H_0 is not rejected. Hence, it can be concluded that each sample originates from a normally distributed population.

Subsequently, the data were analyzed through a homogeneity test to assess the mathematical reasoning ability and self-regulated learning of students in the control and experimental classes. The Bartlett method with Chi-Square test statistics and a significance level of 0.05 was employed for the homogeneity test. The calculation results indicated that for the learning model group, $X^2_{hitung} = 1{,}4301$ and $X^2_{tabel} = 3{,}8415$. While for the self-regulated learning group, the value of $X^2_{hitung} = 3{,}4299$and $X^2_{tabel} = 5{,}991$. Based on these results, it can be seen that the value of X^2_{hitung} in the learning model group and self-regulated learning students do not exceed X^2_{tabel} or X^2_{hitung} ÏDK, so that H_0 is not rejected. Thus, it can be concluded that each sample comes from a homogeneous population.

Hypothesis Test Results

Once the prerequisites for the analysis test were met, a two-way analysis of variance with unequal cells was conducted.

Table 1. Summary of Results of Two-Way Analysis of Variance of Unequal Cells

Source of Variance	JK	dk	RK	Fobs	Fα	Decision
A (Learning model)	70,3931	1	70,3931	25,1403	4,0099	H_0A is rejected
B (Self-regulated learning)	425,2142	2	212,6071	75,9308	3,1588	H_0B is rejected
Interaction (AB)	11,7715	52	5,8858	2,1021	3,1588	H_0AB is not rejected
Error	159,6007	57	2,800			
Total	669,9796	62				

Based on the summary of the results from the two-way analysis of variance with unequal cells concerning the main effect of rows (A), obtained F_a = 25,1403 with DKa = {F | F > 4.009868}. Thus F_a is a member of the critical area, so the test decision H_0A is rejected. This indicates a significant difference in the impact of utilizing learning models on mathematical reasoning ability in probability materials. Thus, the Learning Cycle 7E model and the direct instruction model yield significantly different levels of mathematical reasoning skills in probability material.

Similarly, based on the analysis of variance test results for the main effect of columns (B), obtained F_b = 75,9308 with DKb = {F | F > 3.1588 }. Thus F_b is a member of the critical area, so the test decision H0B is rejected. This suggests an influence of students' self-regulated learning on mathematical reasoning ability in probability materials.

However, concerning the main effect of interaction (AB), obtained Fab = 2,1021 with DKab = {F | F > 3.1588}. Thus F_{ab} is not a member of the critical area, so the test decision H0AB is not rejected. This indicates no interaction between learning models and students' self-regulated learning concerning mathematical reasoning ability in probability materials.

Subsequently, considering the rejected H_0A, it can be concluded that differences exist in the impact of utilizing learning models on mathematical reasoning skills in probability materials. To determine which learning model yields a superior effect on mathematical reasoning ability, a pairwise mean comparison test was conducted. Since only two learning models, the Learning Cycle 7E model and the direct instruction model, were utilized, a comparison of marginal means suffices. The calculated marginal mean for the Learning Cycle 7E model is 13.125, whereas for the direct instruction model, it is 10.742. Hence, the marginal mean for the Learning Cycle 7E model surpasses that of the direct instruction model, indicating that students exposed to the Learning Cycle 7E model exhibit better mathematical reasoning skills than those taught with the direct instruction model.

Additionally, with the rejected H_0B, it can be concluded that discrepancies exist in the impact of students' self-regulated learning on mathematical reasoning ability in probability materials. Since students' mathematical reasoning is categorized into high, moderate, and low self-regulated learning, a multiple comparison test is essential to identify which self-regulated learning group has a superior impact on students' mathematical reasoning ability. This multiple comparison test was conducted using the Scheffe method with a significance level of 0.05. Further details regarding the results of the multiple comparison test between columns are presented in Table 2.

Table 2. Summary of Intercolumn Multiple Comparison Test Calculation Results

$\boldsymbol{H_0}$	$\boldsymbol{F_{hitumg}}$	$\boldsymbol{2F_{tabel}}$	**Test Decision**
μ.1 = μ.2	50,1549	6,3177	H0.1-2 is rejected
μ.1 = μ.3	39,9490	6,3177	H0.2-3 is rejected
μ.2 = μ.3	125,1099	6,3177	H0.1-3 is rejected

According to the summary of the results provided in Table 2, in the average comparison test between the first and second columns, the test decision H0.1-2 was rejected because F_1−2 = 50,1549 Ï DK = {F | F > 6,3177}. This indicates a disparity in the average mathematical reasoning ability between students in the high self- regulated learning and moderate self-regulated learning groups. In other words, students with high self-regulated learning and students with moderate self-regulated learning have significantly different mathematical reasoning ability. Based on the calculation of the marginal mean, the marginal mean of students with high self-regulated learning is 15.4 and the marginal mean of students with moderate self- regulated learning is 11.4375. Thus, the marginal mean score of students with high self- regulated learning is higher than the score of students with moderate self-regulated learning, so it can be concluded that students with high self-regulated learning have better mathematical reasoning ability than students with moderate self-regulated learning.

In the average comparison test between the second and third columns, the test decision H_0. 2-3 was rejected because F_{2-3} = 39,9490 Ï DK {F | F > 6,3177}. This indicates a disparity in the average mathematical reasoning ability between students in the moderate self-regulated learning and low self-regulated learning groups. Essentially, students with moderate self-regulated learning and those with low self-regulated learning exhibit significantly different levels of mathematical reasoning ability. Based on the marginal mean calculation, it was found that the marginal mean score for students with moderate self-regulated learning is 11.4375, while for students with low self- regulated learning, it is 8.3077. Thus, the marginal mean score for students with moderate self-regulated learning surpasses that of students with low self-regulated learning, suggesting that students with moderate self-regulated learning possess better mathematical reasoning ability than those with low self-regulated learning.

In the average comparison test between the first and third columns, the test decision H0.1-3 was rejected because F_{1-3} = 125,1099 Ï DK = {F | F > 6,3177}. This indicates a difference in the mean mathematical reasoning ability between students in the high self-regulated learning and low self-regulated learning groups. Essentially, students with high self-regulated learning and those with low self-regulated learning display significantly different levels of mathematical reasoning ability. Based on the marginal mean calculation, it was found that the marginal mean score for students with high self-regulated learning is 15.4, while for students with low self-regulated learning, it is 8.3077. Thus, the marginal mean score for students with high self-regulated learning surpasses that of students with low self-regulated learning, suggesting that students with high self-regulated learning exhibit better mathematical reasoning ability than those with low self-regulated learning.

Discussion

The analysis of variance test of two-way unequal cells revealed significant findings regarding the main effect of row (A), obtained F_a = 25,1403 with DKa = {F | F > 4.0099}. Thus F_a is a member of the critical area so that the test decision H0A is rejected, meaning that the Learning Cycle 7E learning model and the direct instruction model have different effects on mathematical reasoning ability. Based on the results of the interline average comparison test on each learning model, it was found that students who were subjected to the Learning Cycle 7E learning model had better mathematical reasoning skills than students who were subjected to the direct instruction model. The increase in learning achievement of students who obtained the Learning Cycle 7E learning model because with the Learning Cycle 7E model are attributed to its emphasis on active engagement, critical thinking, and meaningful learning experiences, contrasting with the passive nature of traditional instruction methods.

Similarly, the analysis of variance test of two-way unequal cells regarding the main effect of column (B), obtained F_b = 75,93076 with DKb = {F | F > 3.158843}. Thus F_b is a member of the critical area so that the test decision H0B is rejected, indicating that students' self-regulated learning levels—high, moderate, and low—exert varying impacts on mathematical reasoning ability in probability material. Subsequent multiple comparisons between cells within the same column revealed that students with high self-regulated learning demonstrated superior mathematical reasoning ability compared to those with moderate or low self-regulated learning. Additionally, students with moderate self-regulated learning displayed better mathematical reasoning ability than those with low self-regulated learning. These findings corroborate the notion proposed by Rizqia, Senjayawati, & Kadarisma (2022) that students' mathematical reasoning ability is positively influenced by their level of self-regulated learning.

The analysis of variance of two-way unequal cells regarding the main effect of interaction (AB), obtained F_{ab} = 2,1021 with DKab = {F | F > 3.1588}. Thus F_{ab} is not a member of the critical area, so the test decision H0AB is not rejected. This indicates the absence of a significant interaction between the learning model and students' self-regulated learning (SRL) on their mathematical reasoning ability. Consequently, the focus shifts to the main effect of SRL. This implies that irrespective of the learning model employed—whether Learning Cycle 7E or direct instruction—students with higher levels of SRL consistently exhibit stronger mathematical reasoning skills compared to those with moderate or low SRL. Furthermore, students with moderate SRL consistently outperform those with low SRL across both learning models.

There is no interaction observed between the learning model and students' self-regulated learning concerning mathematical reasoning ability. This conclusion is drawn from the analysis of variance of two-way unequal cells regarding the main effect of interaction (AB), obtained F_{ab} = 2,1021 with DKab = {F | F > 3.1588}. Thus F_{ab} is not a member of the critical area, so the test decision H0AB is not rejected. There is no interaction observed between the learning model and students' self-regulated learning concerning mathematical reasoning ability. This conclusion is drawn from the analysis of variance of two-way unequal cells regarding the main effect of interaction.

CONCLUSION

Based on data analysis and discussion, the conclusions can be drawn that there is a difference in mathematical reasoning ability between students who are subjected to the Learning Cycle 7E learning model assisted by the labyrinth board game learning media and the putar bawah game with students who are subjected to direct instruction model. Students who are subjected to the Learning Cycle 7E learning model assisted by the labyrinth board game learning media and the putar bawah game have better mathematical reasoning skills than students who are subjected to the direct instruction model.

The mathematical reasoning ability of students who study with high, moderate, and low levels of self-regulation differ from one another. Higher self-regulated learners are more capable of mathematical reasoning than lower and moderately self-regulated learners, and lower self-regulated learners are less capable of mathematical reasoning than moderately self-regulated learners.

According to each learning model, students who are highly self-regulated in their learning outperform those who are moderately or poorly self-regulated in their mathematical reasoning. Conversely, students who are moderately self-regulated in their learning outperform those who are low in their mathematical reasoning.

Students who were exposed to the LC 7E learning model, with support from the putar bawah game and the labyrinth board game learning media had better mathematical reasoning abilities at every level of SRL compared to students who were exposed to the direct instruction model.

Building on prior findings, the researchers recommend that teachers adopt the LC 7E learning model as an alternative approach. However, it's crucial to consider other factors that impact learning. Specifically, teachers should monitor students' SRL habits and behaviors throughout the process. By understanding students' SRL levels, teachers can tailor their teaching methods to better suit their students' needs. For discussion activities to go as smoothly as possible, teachers should create diverse groups consisting of students who are equally divided into high, moderate, and low learning motivation groups. Teachers should utilise problems that have multiple possible answers when creating worksheets for their students so that they may give them practice using reasoning to solve difficulties.

During the educational process, students should follow the instructions or learning procedures that have been delivered by the teacher to make it easier to learn concepts and avoid meaning errors. Students should constantly attempt to practice providing several choices for responses to questions in order to improve their ability to reason through issues.

To further enhance students' mathematical reasoning abilities, researchers are encouraged to create technology-based instructional materials or teaching aids that are tailored to the LC 7E learning paradigm. To enhance students' mathematical reasoning abilities, more researchers should create the LC 7E learning model using a different evaluation of resources rather than opportunities.

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DECLARATION

Author Contribution

All authors contribute in the research process, such as collecting the data, analyzing the data, and writing the manuscript. All authors approved the final manuscript.

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Conflict of Interest

Both authors declare that they have no competing interests.

Ethics Declaration

We as authors acknowledge that this work has been written based on ethical research that conforms with the regulations of our institutions and that we have obtained the permission from the relevant institutes when collecting data. We support the International Journal on Emerging Mathematics Education (IJEME) in maintaining high standards of personal conduct, practicing honesty in all our professional practices and endeavors.

REFERENCES

Abror, M. H. (2022). Self-Regulated Learning Terhadap Hasil Belajar Matematika Siswa. *Plusminus: Jurnal Pendidikan Matematika*, 2(2), 233- 242.

Agustiana, N., Supriadi, N., & Komarudin, K. (2019). Meningkatkan kemampuan penalaran matematis dengan penerapan pendekatan bridging analogy ditinjau dari self-efficacy. *Inovasi Pembannan: Jurnal Kelitbangan*, 7(1), 61-61.

Al Ashari, S. R., Mulyono, M., & Mariani, S. (2021). The Ability of Mathematical Reasoning and Self Efficacy Students in Learning Project Based Learning Assisted Moodle. *Unnes Journal of Mathematics Education Research*, 10(2), 220-226.

Annisa, D. (2022). Pengaruh Model Pembelajaran Learning Cycle terhadap Kemampuan Representasi Matematis. *Journal on Education*, *4*(3), 960-967.

Barnes, A. (2019). Perseverance in mathematical reasoning: the role of children's conative focus in the productive interplay between cognition and affect. *Research in Mathematics Education*, 21(3), 271-294.

Berg, D H., & Pamela, A. (2018). Differences in mathematical reasoning between Typically achieving and gifted children. *Thinking & Reasoning*, 30(3), 281- 291.

Budiyono. (2017). *Pengantar Metodologi Penelitian*. Surakarta: UNS Press.

Fauzan, S., & Sari, R. M. M. (2018). *Upaya meningkatkan kemampuan penalaran matematis dengan pendekatan realistic mathematic education pada siswa kelas vii smpn 1 karawang barat*. Prosiding Sesiomadika, 1(1b).

Gulton F.W. & Roesdiana, L. (2019). *Analisis Kemampuan Penalaran Matematis Siswa SMP Pada Materi Operasi Aljabar*. Prosiding Sesiomadika Seminar Nasional Matematika dan Pendidikan Matematika, 2 (1b), 285-297.

Hadi, Samsul. (2022). Profil Kemampuan Penalaran Matematika dan Potensi Kognitif Siswa MA dalam Menyelesaikan Soal Tes Potensi Skolastik (TPS). *Nusra: Jurnal Penelitian dan Ilmu Pendidikan*, 3(2), 320-245.

Helbert, S., Vale, C., Bragg, L. A., Loong, E., & Widjaja, W. (2015). A framework for primary teachers' perceptions of mathematical reasoning. *International Journal of Educational Research*, 74, 26- 37.

Hidayati, A., & Widodo, S. (2015). Proses Penalaran Matematis Peserta didik dalam Memecahkan Masalah Matematika pada Materi Pokok Dimensi Tiga Berdasarzan Kemampuan Peserta didik di SMA Negeri 5 Kediri. *Jurnal Math Educator Nusantara,* 1(2), 1-13.

Marliani, S., & Puspitasari, N. (2022). Kemampuan representasi matematis siswa pada materi kesebangunan dan kekongruenan di kampung sukawening. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 1(2), 113-124.

Masfufah, R., & Afriansyah, E. A. (2021). Analisis Kemampuan Literasi Matematis Siswa melalui Soal PISA. *Mosharafa: Jurnal Pendidikan Matematika*, 10(2), 291-300.

Morsanyi, M., Prado, J., & Richland, L. E. (2018), Editorial: The role of reasoning in mathematical thinking. *Reasoning & Thinking*, 24, 129-137.

NCTM. (2000). *Principle And Standard For School Mathematics*. USA: The National Council of Teachers of Mathematics, Inc.

Siregar, A. P., Risnawati, & Nurdin, E. (2018). Pengembangan lembar kerja siswa berbasis generative learning model untuk memfasilitasi kemampuan komunikasi matematis siswa sekolah menengah kampar. *Jouring (Journal for Research for Mathematics Learning)*, 1(2), 111- 118

Suardana, I. N., Redhana, I. W., Sudiatmika, A. A., & Selamat, I. N. (2018). Students' critical thinking skills in chemistry learning using local culture-based 7E learning cycle model. *International Journal of Instruction*, 11(2), 399-412.

Vale, C., Widjaja, W., Herbert, S., Bragg, L. A., & Loong, E. Y. K. (2017). Mapping variation in children's mathematical reasoning: the case of 'what else belongs?". *International Journal of Science and Mathematics Education*, 15(5), 873-894.

Wibowo, A. (2017). Pengaruh pendekatan pembelajaran matematika realistic dan saintifik terhadap prestasi belajar, kemampuan penalaran matematis, dan minat belajar. *Jurnal Riset Pendidikan Matematika*, 4(1), 1.