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Mathematical Reasoning Ability in Terms of Self-Efficacy in the CORE Learning Model Assisted by Liveworksheet

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ABSTRACT

This study aims to analyze the quality of the CORE learning model assisted by Liveworksheet and examine the effect of self-efficacy on students' mathematical reasoning. A quantitative method with a posttest-only control group design was used. Instruments included a reasoning test, self-efficacy questionnaire, student response questionnaire, and observation sheet. The sample consisted of eighth-grade students at SMPN 16 Semarang, selected through cluster random sampling. Data analysis involved planning, implementation, evaluation, and simple linear regression. The results showed the CORE model with Liveworksheet was of good quality, and self-efficacy significantly influenced mathematical reasoning, contributing 71.6%. It is recommended that the interactive CORE model be further developed along with differentiated teaching tools to ensure learning becomes more adaptive to students' needs.

1. Introduction

The rapid progress that has occurred in the world of science and technology is closely related to the essential contribution of mathematics, which serves as the main foundation in various disciplines and applied fields. Well-mastered mathematical skills will be an important asset for every individual to face challenges, make the right choices, and adapt to an ever-changing world (Herman et al., 2024). One of the crucial aspects that every student must master in mathematics learning activities is mathematical reasoning ability. If knowledge about reasoning is integrated into the curriculum, it will undoubtedly have a positive impact on mathematics learning (Basir et al., 2022).

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Mathematical reasoning is a crucial competency that enables students to internalize and apply mathematics substantively through the construction of original ideas. This process facilitates the drawing of logical and valid mathematical conclusions based on the analysis of available data, facts, or statements (Masriyah et al., 2024). Mathematical reasoning ability is a process of systematic and logical thinking, comprehensively analyzing information, generating valid conclusions along with evidence, and applying mathematical concepts in various problem contexts (Lithner, 2008). This is supported by findings in studies conducted by (Jariyah et al., 2024) and (Kusumawardani et al., 2018), which reveal that mathematical reasoning is a cognitive skill that relies on a sequential thinking process to produce logical and accountable conclusions based on verified evidence. Based on the various perspectives presented, it can be concluded that mathematical reasoning is a form of logical and structured thinking process used to understand information, analyze relationships between concepts, and draw valid conclusions based on evidence and data whose accuracy can be accounted for.

Findings from various previous studies indicate that students' mathematical reasoning abilities are low. The study by (Nabila & Marlina, 2022) found that the mathematical reasoning abilities of eighth-grade junior high school students in Karawang are still low. The cause of this condition is that there are still a number of students who do not fully understand the content or meaning of the questions presented, are not careful enough in analyzing and interpreting the content of the questions, resulting in students answering carelessly and having difficulty solving problems because they do not use their reasoning skills properly.

Similar findings were obtained in seventh grade junior high school students that mathematical reasoning ability is still in the low category, many students face obstacles when trying to solve a contextual problem that contains mathematical reasoning indicators, students find it difficult if the exercise problem is different from the example problem (Yerizon et al., 2024). If students lack mathematical reasoning skills, they tend to face obstacles in understanding and solving mathematical problems (Nasir et al., 2023). Therefore, mathematical reasoning skills in mathematics learning must be continuously trained and honed through teachers who regularly provide challenging problems requiring higher-order thinking skills (HOTS) (Sari et al., 2023)(Sumartini, 2015). In addition to mathematical reasoning skills, one of the affective factors that plays a crucial role in predicting students' success in solving mathematics problems is self-efficacy (Smit et al., 2023).

Self-efficacy refers to an individual's belief in their personal capacity to organize and carry out various strategic actions needed to achieve the desired level of performance or results (Dinther et al., 2011)(Badura, 1997). The characteristics of self-efficacy are specific to certain fields and influenced by context, meaning that an individual's belief in their abilities will vary depending on the situation they are facing. Individuals in the learning process who have high self-efficacy tend to demonstrate better academic performance, as they possess strong intrinsic motivation and persistence in taking appropriate actions. Conversely, individuals with low self-efficacy tend to show vulnerability to feelings of despair, resignation, and avoidance of assigned tasks (Kul et al., 2024).

Self-efficacy is related to mathematical reasoning ability; a lack of mathematical reasoning ability may be due to a lack of self-efficacy among

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students efficacy (Smit et al., 2023). This is reinforced by research conducted by (Hadiat & Karyati, 2019) which found that the higher the level of self-efficacy among students, the higher their mathematical reasoning abilities. (Jumiarsih et al., 2020) stated that this is because students with high levels of self-efficacy tend to be more confident in facing mathematical challenges. They are more active in engaging in the learning process, attempting to solve difficult problems, and not easily giving up when faced with difficulties. Conversely, students with low self-efficacy are more likely to feel anxious or afraid of failure, which can hinder them from practicing and developing their mathematical reasoning abilities.

Students' self-efficacy can be enhanced through the implementation of active learning, especially when such learning involves everyday problems closely related to students' lives (Hanifah et al., 2021). Therefore, a learning model is needed that not only promotes the development of cognitive abilities such as mathematical reasoning but also strengthens students' self-confidence or self-efficacy in the learning process. One of the relevant learning models to address this need is the Connecting, Organizing, Reflecting, Extending (CORE) learning model.

The CORE learning model is one of the alternative learning models that aims to activate students in constructing their own understanding (Latifah et al., 2025). Through the stages of connecting, organizing, reflecting, and expanding, this learning model facilitates students in integrating, organizing, exploring, and developing the information they have obtained (Rahmadhani et al., 2024). Therefore, the clearly structured stages in the CORE learning model have the potential to make learning a more valuable experience and help students achieve learning objectives more effectively (Muhammadiah et al., 2023). Additionally, in order to optimize the implementation of the CORE learning model, which emphasizes active and constructive student involvement, support from digital learning media that can effectively facilitate this process is required. The presence of interactive media not only strengthens the implementation of the stages in the CORE model but also significantly contributes to facilitating students' understanding of complex and challenging learning topics, such as mathematical concepts. One form of digital learning media innovation relevant to this need is Liveworksheet.

Liveworksheet, as a free online platform, empowers educators to create or utilize interactive Electronic Student Worksheet, transforming conventional worksheets, such as Student Worksheet, which are typically printed, into more personalized and challenging digital learning activities for students (Rosidah et al., 2023)(Le & Prabjandee, 2023). The use of Liveworksheet can help make learning more effective, as this model encourages direct student participation in teaching and learning activities, thereby reducing passive attitudes during the learning process (Sugandi et al., 2024). When integrating complex problems into Electronic Student Worksheet based on Liveworksheet, it can facilitate a deeper understanding of mathematical concepts and significantly develop students' mathematical reasoning skills. This is supported by research conducted by (Ahmar & Soro, 2023; Atiyah & Priatna, 2023) which shows that the implementation of the CORE learning model and the use of Liveworksheet-based Electronic Student Worksheet can improve mathematical reasoning skills.

The research results show that the average reasoning ability of students in the experimental class is higher than that of students in the control class. This is because in the CORE learning model, students are actively involved through four

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stages, namely: Connecting, where students connect new knowledge with existing knowledge. Organizing, where students are encouraged to organize the information they have learned so that they can understand the structure and relationships between concepts. Reflecting, where students reflect on their learning process, enabling them to evaluate their understanding and the strategies they have used. Extending, where students are encouraged to expand their knowledge by applying the concepts they have learned in a broader context or in new situations.

This study is similar to the research conducted by (Hadiat & Karyati, 2019), which found that mathematical connection skills, curiosity, and self-efficacy are collectively related to mathematical reasoning skills, contributing 46.3% to the overall outcome. Furthermore, based on the findings in the study by (Sari et al., 2021), it was found that self-efficacy has a positive effect on mathematics learning outcomes. (Wiharso & Susilawati, 2020) concluded in their study that improving students' connection skills through CORE learning shows advantages over conventional learning. (Mahanani et al., 2023) concluded in their study that implementing liveworksheets in learning activities contributes positively to improving students' mathematics learning outcomes. Based on the above discussion, previous studies have indeed addressed similar topics related to mathematical reasoning ability, self-efficacy, the CORE learning model, and Liveworksheet.

This study presents a unique approach by integrating all four aspects simultaneously, thereby offering novelty compared to previous research. Based on the previous explanation, this study aims to achieve the following: (1) to determine the quality of the CORE learning model assisted by Liveworksheet? (2) To determine the influence of students' self-efficacy on their mathematical reasoning abilities in the CORE learning model supported by Liveworksheet. In light of this, this study is expected to provide concrete benefits in expanding the scope and strategies of mathematics education, which are not solely focused on developing mathematical reasoning abilities but also simultaneously build students' self-efficacy in learning activities. Through the application of the CORE learning model supported by interactive media such as Liveworksheet, this study is expected to serve as a reference for teachers in designing more meaningful, adaptive, and responsive learning activities to meet the learning needs of students in the digital age.

2. Method

This study uses a quantitative method based on positivism philosophy, in which numerical data is used in the research process on a specific population or sample group, collected through instruments, then analyzed statistically to test hypotheses and conclude the results of the study (Sukestiyarno, 2021). This study uses a Posttest-Only Control Group Design, in which there are two randomly assigned groups, namely the experimental group and the control group. The following is an illustration of the Posttest-Only Control Group Design model.

Group	Treatment	Posttest
R_1	X_1	O
R_2	X_2	O

Figure 1. Posttest-Only Control Group Design Model

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The population in this study included all eighth-grade students at SMP Negeri 16 Semarang. Sampling was conducted using the Cluster Random Sampling technique, which resulted in an experimental group and a control group, namely eighth grade classes C and D. The techniques used in data collection included tests to measure mathematical reasoning ability, self-efficacy questionnaires, observation sheets on the implementation of learning, and questionnaires to assess students' responses to the learning process. Data collection was carried out systematically using several instruments according to the research needs.

First, a mathematical reasoning ability test was used to obtain quantitative data on the mathematical reasoning abilities of students after the treatment was given. Second, a self-efficacy questionnaire was used to measure the level of students' self-confidence in their ability to complete mathematical tasks. The results of this questionnaire were used to determine the effect of self-efficacy on mathematical reasoning abilities. Third, an observation sheet on the implementation of learning was used to measure the quality of the implementation of the CORE learning model assisted by Liveworksheet in the experimental class. Observations were made by observers during the learning process to ensure objectivity and consistency of implementation. Finally, a questionnaire on students' responses to the learning process was distributed after the treatment was given.

This instrument aims to determine students' perceptions and responses to the learning model applied. Data analysis was conducted through four stages: (1) analysis of learning planning data, analyzing learning tools and assessment instruments by expert validators; (2) analysis of learning implementation data, assessing the implementation of learning activities during the learning process by observers; (3) learning evaluation data analysis, analyzing data through prerequisite tests in the form of normality tests, homogeneity tests, followed by hypothesis tests in the form of one-tailed t-tests to test the average completeness, one-tailed z-tests to test the proportion of completeness, and two-sample mean tests to test the difference in means; (4) To measure the effect of self-efficacy on mathematical reasoning ability in the CORE model assisted by Liveworksheet, simple linear regression analysis was used. This analysis aims to determine the extent to which the self-efficacy variable contributes to predicting students' mathematical reasoning ability. The collected data was analyzed in three stages. This study refers to the following learning quality achievement (Khardita et al., 2023).

Table 1. Learning Quality Achievement

Stage	Achievement
Planning	Valid and at least categorized as good
Implementation	At least categorized as good
Assesment	Learning is effective if (1) Average score is satisfactory (2) ≥ 75% of students are satisfactory (3) Experiment score >control (4) Completion rate with CORE learning > Problem Based Learning (PBL) (5) *Self-efficacy* is influential

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3. Results and Discussion

This section presents the results of research highlighting the quality of learning implementation by applying the CORE model supported by the use of Liveworksheet. In addition, it also explains the extent to which students' self-efficacy contributes to their mathematical reasoning abilities while participating in learning with the CORE model assisted by Liveworksheet.

3.1. CORE Learning Quality Assisted by Liveworksheet

Quality mathematics learning is characterized by interactive and inspiring processes that motivate students to participate actively. An effective learning environment is also challenging, enjoyable, and provides adequate opportunities for the development of students' initiative, creativity, and independence (Siregar et al., 2021). The quality of learning has three stages, namely: Planning, Implementation, and Assessment. Quantitatively, the quality of learning is evaluated based on two main criteria: first, the performance of the experimental group is significantly superior to that of the control group; second, the achievement of learning completeness by students.

3.1.1. Planning

During the planning stage, researchers designed teaching modules, Liveworksheet-based E-LKPD, mathematical reasoning tests, interview guidelines, and self-efficacy questionnaires. The learning tools were then validated by two lecturers from the UNNES Postgraduate Mathematics Education Study Program who are experts in the field of mathematics education, as well as a mathematics teacher from class VIII at SMP Negeri 16 Semarang. The following is an expert evaluation of the learning instruments that have been designed.

Table 2. Average Results of Expert Assessment of Learning Device Quality

Learning Tools	Overall Average
Teaching Modules	4.8
Liveworksheet-based Electronic Student Worksheet	4.7
Mathematical Reasoning Ability Test (MRAT)	4.8
Interview Guidelines	4.8

Referring to Table 2, it can be seen that the average overall score from the validation stage for the teaching module device is 4.8. The average Electronic Student Worksheet score is 4.7. The average MRAT score is 4.8. The average interview guideline score is 4.8. Based on the average overall validation scores, all learning devices received a rating in the "very good" category. Therefore, it can be concluded that these learning devices are suitable for use.

3.1.2. Implementation

The learning activities were conducted in four sessions. During the learning activities, which used the CORE model supported by Liveworksheet in the experimental class, the observer observed the learning process in accordance with the assessment listed in the learning implementation assessment sheet. The following is the observer's assessment of the learning implementation.

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Table 3. Average Observer Assessment of Learning Implementation

Meeting	Overall Average
1	4.11
2	4.21
3	4.47
4	4.68
Total Average	4.37

Referring to Table 3, the average implementation of learning in the first meeting was recorded at 4.11 and was classified as good. In the second meeting, there was an increase in the average score to 4.21, which was classified as very good. The third session showed an average of 4.47, also in the very good category. Furthermore, the fourth session recorded an average of 4.68, which is still in the very good category. Overall, the total average of the observation results for learning implementation was 4.37. These findings indicate that learning using the CORE model with the assistance of Liveworksheet is classified as very good and is running well.

In addition, from the analysis of the response questionnaire filled out by students after the learning process using the CORE model combined with Liveworksheet, which consisted of 17 statements with a rating scale of 1 to 5, the average total score was 4.21. This result shows that the score falls into the excellent category. This finding reflects that the implementation of the learning process has been carried out with good quality.

3.1.3. Assesment

The assessment stage aims to evaluate the effectiveness of learning using the CORE model with the help of Liveworksheet on mathematical reasoning abilities. Before conducting the effectiveness test, a prerequisite test was first conducted. The prerequisite tests used were normality and homogeneity tests. The following are the results of normality and homogeneity tests.

Table 4. Normality Test Results

Group	Sig. Shapiro Wilk	α
Experimental	0.450	0.05
Control	0.527	0.05

Based on the results of the normality test using Shapiro Wilk, the significance value for the experimental class is $\text{sig} = 0.450 > 0.05 = \alpha$, while the significance value for the control class is $\text{sig} = 0.527 > 0.05 = \alpha$, so H_0 is accepted, meaning that the data comes from a normally distributed population.

Table 5. Homogeneity Test Results

Sig. Levene Statistic	α
0.868	0.05

Based on the results of the homogeneity test using Levene's statistic, a value of $\text{sig} = 0.868 > 0.05 = \alpha$ was obtained, so H_0 was accepted, indicating that the variances of the two classes (experimental and control) were the same or homogeneous. The data showed that the experimental class and the control class had normal and homogeneous distributions. Before continuing with the

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hypothesis test, the Batas Tuntas Aktual (BTA) was first determined. The following is the formula for determining the BTA,

$$BTA = \bar{X} + 0.25\, SD \quad (1)$$

Explanation:
$\bar{X}$: initial MRA average
SD : standard deviation

The next test was conducted on the average achievement by applying a t-test at a significance level of $\alpha = 0{,}05$. It was concluded that $t_{count} = 5.348 \geq 1.692 = t_{table}$, in other words, the average mathematical reasoning ability of students in the experimental class had reached BTA = 60. The classical completeness test using the z-test resulted in $z_{count} = 1.837 \geq 1.65 = z_{table}$, meaning that the proportion of students' mathematical reasoning ability using the CORE learning model assisted by Liveworksheet reached more than 75%. The results of the two-sample mean test prove that $t_{count} = 3.0919 > t_{table} = 1.668$. This finding indicates that the average mathematical reasoning ability of students in the experimental class is significantly higher than that of students in the control class. The proportion difference test yielded $z_{count} = 2.049 \geq 1.65 = z_{table}$, meaning that the proportion of mathematical reasoning ability mastery in the CORE model assisted by Liveworksheet is higher than the proportion of mathematical reasoning ability mastery in PBL learning.

Based on the results of the above analysis, it can be seen that the application of the CORE learning model assisted by Liveworksheet is effective in improving mathematical reasoning skills. During the learning process, there were changes in classroom interaction, activities, and student enthusiasm for learning through the use of new models and media. Learning began with the connecting stage, where teachers linked PLSV concepts to real-life situations, such as calculating the total cost of shopping at a minimarket, dividing daily pocket money, or determining the remaining money after purchasing several items.

Students became more interested because the problems no longer felt abstract but were closely related to their daily lives. Many students began actively answering and sharing personal experiences related to the problem situations. During the organizing stage, students were guided to group important information from the problems and outline solution steps using Liveworksheet. This interactive medium presents problems in the form of stories. Students show high enthusiasm, actively discussing in groups and checking their work. The classroom atmosphere is lively; students are not only solving problems but also beginning to understand the patterns of solutions and the logical reasoning behind their steps. In the reflecting stage, students are asked to explain their thought processes and compare their answers with their peers. They discuss, correct, and even give each other suggestions.

Students who are usually quiet began to dare to express their opinions, especially after gaining confidence from successfully answering questions correctly. This stage shows that the learning process encourages students to think critically and believe in their own abilities (self-efficacy). In the extending stage, students are given enrichment questions in the form of stories, such as determining the width of a swimming pool after knowing its length and circumference. These

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questions not only require students to apply basic formulas but also involve an understanding of geometry and algebra concepts to solve them. Students need to analyze the information provided and formulate equations based on the given conditions.

The students' responses were very positive, with some even requesting additional problems because they felt challenged and wanted to try more exercises through Liveworksheet. This is supported by research by (Widiastuti et al., 2022), which shows that the average mathematical reasoning ability of students in classes using the CORE learning model is superior to the average in classes using expository learning. Additionally, this is supported by the findings of (Ahmar & Soro, 2023), who found that Electronic Student Worksheet based on Liveworksheet in mathematics learning can influence students' mathematical reasoning abilities. This is also evident from the average scores of both classes, where the class using Electronic Student Worksheet based on Liveworksheet had a higher average of 6.807 points.

3.2. The Influence of Students' Self-Efficacy on Mathematical Reasoning Ability in the CORE Learning Model Assisted by Liveworksheet

Self-efficacy is an important factor that can influence students' mathematical reasoning abilities. To determine this, a simple linear regression test was used to examine the influence of students' self-efficacy on their mathematical reasoning abilities in the CORE learning model assisted by Liveworksheet. In the linear regression test with interval questionnaire data using the Method of Successive Intervals (MSI), which was then tested using SPSS 22.0, several test results were obtained, namely the linearity test of the regression equation, the regression significance test, the correlation test, and the calculation of the coefficient of determination.

Table 6. Results of Linearity Test and Regression Significance Test

	Sig.	α
Deviation from Linearity	0.301	0.05
Regression	0.0000	0.05

Based on the output results in table 4, the linearity significance value of 0.301 exceeds $\alpha = 0.05$. Thus, the regression equation $\hat{Y} = 7.673 + 0.865X$ can be declared linear. Furthermore, based on the regression significance test results listed in the ANOVA Table, a significance value of 0.000 was obtained, which is smaller than the significance level $\alpha = 0.05$. This shows that self-efficacy has a significant effect on students' mathematical reasoning ability.

Table 7. The Result of Correlation Test

		MRAT	**SE**
Pearson Correlation	MRAT	1.000	0.846
	SE	0.846	1.000
Sig.	MRAT	.	0.000
	SE	0.000	.

Based on the output results in Table 5, the significance value is $0.000 < 0.05$, which means there is a significant relationship between self-efficacy and mathematical reasoning ability. In other words, the higher the self-efficacy of students, the better

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their ability to do mathematical reasoning.

Table 6. Coefficient of Determination

R	R Square
0.846	0.716

Based on the output in the summary table, the R Square (r^2) value = 0.716, is obtained, which is converted into a percentage becomes $D = 0.716\,x\,100\% = 71.6\%$. This means that 71.6% of the variability in students' mathematical reasoning ability can be explained by the self-efficacy variable, while the remaining $100\% - 71.6\% = 28.4\%$ is influenced by other factors outside self-efficacy, such as learning strategies, cognitive background, learning environment, and intrinsic motivation.

Based on the findings of this study, it is known that self-efficacy has a positive effect on mathematical reasoning ability. Discussion and group work activities were actively participated in by the majority of students, but there were also some students who did not show optimal participation in these activities. Students with high levels of self-efficacy tend to be active in the learning process in class and in completing mathematical tasks (Imaroh et al., 2021). When they encounter difficulties in understanding the teacher's explanations, they do not hesitate to ask questions to gain a better understanding of the material. In addition, they are also able to consistently solve the problems given with good results.

The learning situation in the classroom shows that students with high self-efficacy also demonstrate high mathematical reasoning abilities, and the opposite is true for students with low self-efficacy. This is because students with high self-efficacy have self-confidence, are confident in the results of their work, which is considered more difficult, and are willing to take risks so that learning objectives are achieved achieved (Amir et al., 2021). Thus, the higher the level of self-efficacy among students, the greater their mathematical reasoning ability, and vice versa (Negara et al., 2024). This is due to the important role of students' self-confidence in determining how they manage the learning process, understand concepts, and face challenges. This belief encourages students to keep trying to solve the problems they face, thereby sharpening their reasoning skills.

Based on the research results, it is recommended that the CORE learning model continue to be developed as an effective approach to improving mathematical reasoning skills, especially when combined with interactive media such as Liveworksheet. The integration of digital learning technology needs to be expanded to support higher-order thinking processes among students. In addition, it is important for teachers to design learning activities that can increase self-efficacy, as this has been proven to have a significant effect on mathematical reasoning. This research also opens up opportunities for application at different levels and in different contexts to test the consistency of results. It is also recommended that differentiated instructional tools be developed to make learning more adaptive to students' needs. Finally, collaboration between researchers, teachers, and policymakers is necessary to ensure that learning innovations can be widely and sustainably implemented.

4. Conclusions

Based on the results and discussions of the research described above, it was found

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that the CORE learning model supported by Liveworksheet media has excellent quality in terms of students' mathematical reasoning abilities. The quality of the instructional planning phase received very good ratings from validators, with an overall average score for each instructional tool, such as the instructional module (4.8), Electronic Student Worksheet (4.7), mathematical reasoning test (4.8), and interview guidelines (4.8). The quality of the implementation stage, with the average observation of learning implementation, showed an increase from the first meeting (4.11) to the fourth (4.68), with an overall average of 4.37, and student responses received very good results with an average score of 4.21.

The quality of the assessment stage revealed that the CORE model assisted by Liveworksheet was effective in improving mathematical reasoning skills, with the average mathematical reasoning ability of students in the experimental class reaching BTA = 60, the proportion of students' mathematical reasoning ability with the CORE model assisted by Liveworksheet reached more than 75%, the average mathematical reasoning ability of students in the experimental class was significantly higher than that of students in the control class, and the proportion of mathematical reasoning ability mastery in the CORE model assisted by Liveworksheet was higher than the proportion of mathematical reasoning ability mastery in PBL learning.

Self-efficacy was found to have a significant effect on students' mathematical reasoning ability, as shown by the results of simple linear regression, which indicated a significance value of $0.000 < 0.05$ with a coefficient of determination R Square (r^2) = 0.716. This means that 71.6% of the variation in mathematical reasoning ability can be explained by the level of self-efficacy, while the remaining 28.4% is influenced by other factors.

Author Contributions

The first author carried out the task of collecting data, processing it, analyzing the results, and compiling scientific articles. The second and third authors played a role in providing constructive suggestions and input to develop the study, strengthen the analysis, and improve the content of the manuscript.

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Declaration of Competing Interest

There are no indications of potential conflicts of interest disclosed by the authors.

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