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## **IMPROVING STUDENTS' MATHEMATICAL COMPREHENSION AND CURIOSITY THROUGH DEEP LEARNING CYCLE LEARNING WITH THE HELP OF PROPROFS**

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### **ABSTRACT**

This research is a quasi-experimental study that aims to investigate the effectiveness of the Deeper Learning Cycle (DELIC) model supported by ProProfs media in improving students' mathematical comprehension and curiosity. The objectives of the study include: (a) describing the implementation of the Deeper Learning Cycle (DELIC) model assisted by ProProfs, (b) analyzing the improvement and acquisition of students' mathematical understanding, and (c) investigating the increase in students' mathematical curiosity before and after the learning process. The study was carried out at MTs Mathla'ul Huda Baleendah, involving class VIIA as the experimental group and class VIIIB as the control group, employing a nonequivalent control group design. The findings indicate that: (1) the implementation of the Deeper Learning Cycle (DELIC) model assisted by ProProfs was executed very effectively; and (2) the enhancement and attainment of mathematical understanding in the experimental group were significantly greater than those in the control group; and (3) there was a notable increase in students' mathematical curiosity after the implementation. These findings suggest that integrating the Deeper Learning Cycle (DELIC) model with ProProfs media is effective in fostering meaningful and engaging mathematics learning.

**Keywords:** Mathematical Comprehension Ability, Deeper Learning Cycle, Proprofs, Mathematical Curiosity.

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### **PRELIMINARY**

The role of mathematics as a basic science is very important in helping humans understand and solve various life problems. In the context of mathematics learning, students' abilities are not only measured through calculation skills, but also through the ability to think logically and critically in solving the problems they face (Salwa et al., 2025). This opinion is in line with (Rosmayadi et al., 2018) that the aim of learning mathematics at every level of education, from elementary school to university, is to train students to be able to think logically, analytically and systematically. Mathematics also acts as a foundation for the development of various other scientific disciplines, especially in the era of globalization and

industrial revolution 4.0 which requires students to have *higher order thinking skills* (HOTS). However, in reality, the mathematics learning process in many educational institutions is still dominated by a procedural approach that emphasizes memorizing formulas and solving problems technically without strengthening conceptual understanding (Wahyuni et al., 2022). In fact, understanding mathematical concepts is a fundamental aspect needed to develop students' mathematical reasoning abilities.

Mathematics plays an important role in education. Therefore, it is necessary to design appropriate and effective learning models to support students in achieving an optimal understanding of mathematical concepts in a way that is easy to comprehend. Through effective learning processes, students can develop logical thinking skills, communicate ideas clearly, and solve mathematical problems quickly and accurately. Junior high school students need to have a strong understanding of mathematics and problem-solving abilities as part of a comprehensive education. Mathematics is taught from elementary school through the final years of senior high school because it has a crucial role in supporting students' daily activities. In addition, students' understanding of mathematical concepts at the secondary level is strongly influenced by their learning experiences during elementary school (Putra et al., 2018).

Students' understanding and ability to apply subject matter cannot be separated from the influence of the media and learning models used, because both play a role in integrating various elements in the teaching and learning process (Sriyanti et al., 2020). Selection of relevant learning strategies has an important role in creating an effective learning process. Therefore, learning models and media must be able to support the formation of students' conceptual understanding so that mathematics learning does not only focus on results, but also develops critical and meaningful ways of thinking (Dewi et al., 2025).

Increasing students' mathematical understanding needs attention because it is still a prominent problem in the world of education, as shown by various previous research results. A similar phenomenon was also identified in a preliminary study at MTs Mathla'ul Huda, where the majority of students experienced difficulty in solving mathematics problems that required understanding concepts. The results of the analysis of students' answers show that the ability to reason information, design problem-solving strategies, and communicate solution steps logically and systematically is still relatively low. This condition shows that students' mathematical understanding has not developed optimally and has the potential to hinder the achievement of overall mathematical competence.

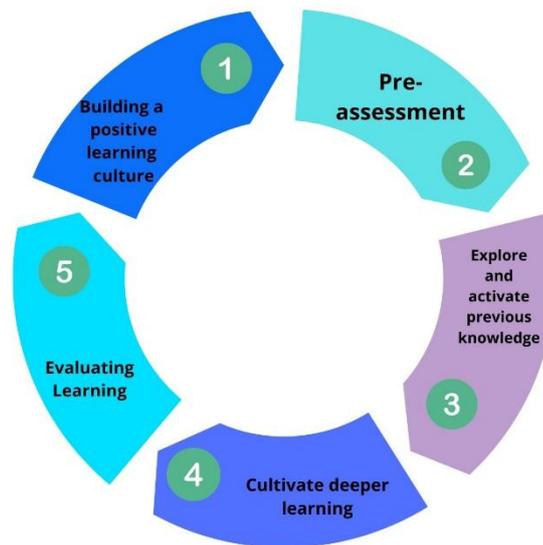
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Students' active participation in mathematics learning activities also needs attention, because the level of student involvement has a significant impact on achieving learning outcomes (Ferdianto & Ghanny, 2014). Passive and monotonous learning can reduce students' level of participation and curiosity. This is an important challenge for educators in creating a more active and meaningful learning process (Rahayu et al., 2019). According to (McElmeel, 2002) Curiosity is an important factor that encourages students to learn and understand concepts in depth. Therefore, teachers need to create cognitively challenging learning situations so that students are encouraged to think critically and discover knowledge independently (Nhat & Le, 2023).

The application of the Deeper Learning Cycle (DELC) model is an alternative that can be used to improve the quality of the mathematics learning process (Sitorus et al., 2020). This model aims to increase student understanding of concepts and active participation through learning stages that emphasize critical, collaborative, reflective and creative thinking skills (Jensen & Nickelsen, 2011). The DELC model is designed to increase students' active involvement in meaningful learning, by emphasizing the ability to reason, relate concepts to everyday life, and solve problems independently, rather than just memorizing procedures and formulas (Sitompul et al., 2025).

Previous research shows that the Deeper Learning Cycle (DELC) model is effective in increasing students' motivation, engagement and conceptual understanding of mathematics ka (Fadilla, 2023). This model also supports the creation of interactive and meaningful learning, thereby increasing students' enthusiasm and motivation in understanding mathematical concepts (Siregar et al., 2025). The Deeper Learning Cycle (DELC) model has the potential to be a solution for improving mathematical understanding and the quality of learning that emphasizes deep thinking processes. The stages of implementation in the classroom are presented in Figure 1.

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**Figure 1. Learning Cycle Deeper Learning Cycle (DELC)**

The Deeper Learning Cycle (DELC) model in mathematics learning emphasizes the importance of teacher guidance and adapting learning to student abilities so that the potential of each student can develop optimally (Raup et al., 2022). This model functions to foster students' learning independence, responsibility and reflective thinking abilities in understanding mathematical concepts (Mutmainnah et al., 2025).

The development of digital technology has driven changes in the world of education towards learning systems that are more interactive, adaptive and relevant to life contexts. Digital media plays an important role in providing a more interesting and meaningful learning atmosphere (Daryanes & Ririen, 2020). *ProProfs Quiz Maker* is a digital media that supports interactive and interesting mathematics learning. Apart from being an evaluation tool, this media also plays a role in increasing student engagement and learning motivation through active and fun learning (Nurjanah et al., 2022). The integration between the *Deeper Learning Cycle* (DELC) model and the *ProProfs Quiz Maker* digital media has the potential to be an effective approach to creating mathematics learning that is not only meaningful, but also challenging and relevant to current developments.

The use of ProProfs in mathematics learning allows students to actively interact with the material through interactive features such as game-based quizzes, automatic assessments, and concept visualizations (Wijaya, 2018). ProProfs features help create an interesting learning atmosphere while strengthening understanding of concepts, especially for students with visual and kinesthetic learning tendencies. By integrating the Deeper Learning Cycle (DELC) model and digital media, the learning process is expected to be more comprehensive, innovative, and in line with the character of 21st century students. This

approach not only improves mathematical understanding, but also fosters students' curiosity and explorative spirit (Zetriuslita, 2016).

Based on the description above, increasing students' mathematical understanding requires mutually supportive learning approaches and media. It is believed that the integration between the Deeper Learning Cycle (DELIC) model and ProProfs media can be an innovative alternative in increasing students' mathematical understanding and curiosity. Therefore, this research aims to examine the effectiveness of implementing the DELIC model assisted by ProProfs in improving the quality of mathematics learning to be more effective and meaningful.

## METHODS

This type of research is quantitative research with a quasi-experimental method that applies a *pre-test and post-test design with non-equivalent control group*, where there are two classes that act as an experimental group and a control group (Sugiyono, 2016). The experimental group received instruction using the Deeper Learning Cycle (DELIC) model, while the control group was taught through conventional methods. Both groups were administered a pretest prior to the treatment and a posttest after the learning process. The results of these tests were then analyzed to determine changes in students' abilities (Ishtiaq, 2019).

This research involved all 47 class VII students at MTs Mathla'ul Huda Baleendah who were divided into two classes. Sampling was carried out by random sampling with consideration of ease of implementation and time efficiency. Class VII A is designated as an experimental class using the Deeper Learning Cycle (DELIC) model assisted by ProProfs, while class VII B is a control class with conventional learning.

Before implementing the Deeper Learning Cycle (DELIC) supported by the ProProfs application, students completed a mathematical understanding test (pretest) to determine their initial level of mathematical understanding. After the learning process using the Deeper Learning Cycle (DELIC) assisted by the ProProfs application and the conventional learning approach was completed, students were given a posttest.

The first step undertaken by the researcher was problem identification, which involved determining the research focus. The next stage was reviewing relevant literature and selecting a research setting that aligned with the identified problem. Subsequently, the researcher developed the research instruments. The instruments used in this study included observation sheets for teacher activities related to instructional stages, observation sheets for

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student activities, mathematical understanding test items, and a questionnaire measuring students' mathematical curiosity. The research design used to examine the improvement of students' mathematical self-curiosity in the experimental class is presented in Table 1.

**Table 1. Mathematical Curiosity Research Design**

<b>Class</b>	<b>Pre-Questionnaire</b>	<b>Treatment</b>	<b>Post-Questionnaire</b>
Experiment	O	X	O
Control	-	-	-

Before the implementation of the Deeper Learning Cycle (DELIC) supported by the ProProfs application, students completed a mathematical self-curiosity questionnaire (pre-questionnaire) to determine their initial level of mathematical self-curiosity. After the DELIC learning process assisted by the ProProfs application was completed, students were given a post-questionnaire to identify the improvement in their mathematical self-curiosity before and after the DELIC-supported learning.

The instruments used in this research consisted of a mathematical understanding ability test, a mathematical curiosity questionnaire, and teacher and student observation sheets. The test consists of 12 Social Arithmetic questions given at the pretest and posttest stages. The curiosity questionnaire contains 20 statements that are filled in before and after implementing the Deeper Learning Cycle (DELIC) model assisted by ProProfs. Observation sheets are arranged according to the learning stages in the DELIC model. The test and questionnaire data were analyzed using SPSS version 25 for Windows through a paired sample t-test to examine the improvement and differences in N-Gain scores based on normalized gain criteria.

## **RESULT AND DISCUSSION**

### **Implementation of Deeper Learning Cycle (DELIC) Learning Assisted by ProProfs**

Learning activities using the Deeper Learning Cycle (DELIC) model supported by the ProProfs application were implemented to improve students' mathematical understanding abilities. Prior to the implementation, the researcher conducted a trial test of the instruments to validate each test item that would be used in the study. The instrument trial was carried out with class VIII B. After the trial process, the researcher implemented the treatment in class VII A, which used the DELIC learning model assisted by the ProProfs application, and in class VII B, which used a conventional learning model.

The learning implementation was divided into five phases. Phase 1 : Involved building a positive learning culture. A positive learning culture serves as an important foundation for creating a safe, inclusive classroom environment that supports active student participation. It aims to establish a healthy learning atmosphere in which students feel valued, are not afraid of making mistakes, and are free to express ideas and opinions.

Phase 2: Consisted of pre-assessment activities. Pre-assessment is an essential initial step in the learning process because it provides teachers with an overview of students' prior knowledge, understanding, and skills before starting a new topic. Through pre-assessment, teachers can identify which concepts have been mastered, which require further reinforcement, and where gaps in understanding exist. This information allows teachers to adjust time allocation and learning strategies, making the learning process more focused, efficient, and aligned with students' needs.

Phase 3: Exploring and Activating Prior Knowledge. In this stage, the mathematics teacher first helps students gather supporting content to optimize learning before moving to more in-depth material. This supporting content may include reading materials, mathematics learning videos, interactive applications, example cases in mathematics, or additional references relevant to the topic being studied. By providing these resources, the teacher establishes a strong foundation that enables students to more easily understand and apply more complex mathematical concepts in subsequent learning activities.

Phase 4: Deep Processing of Learning Activities. In this stage, the teacher guides students in breaking down social arithmetic material into smaller components, such as cost price, selling price, profit, and loss. Students are then assisted in analyzing the relationships among these components and reconstructing them into a comprehensive understanding. The teacher also encourages students to become aware of what they are learning and why it is important, for example by asking reflective questions that connect the lesson to real-life situations.

Phase 5: Evaluating Student Learning Activities. At the evaluation stage, the teacher plays an important role in measuring the extent of students' understanding of the material that has been learned. Evaluation is not only intended to assess final outcomes but also to reflect on the overall learning process. Through structured and comprehensive evaluation, the teacher can identify students' strengths and weaknesses and determine the necessary follow-up actions. Evaluation also serves to confirm whether the learning objectives have been achieved and whether the instructional approach used has been effective.

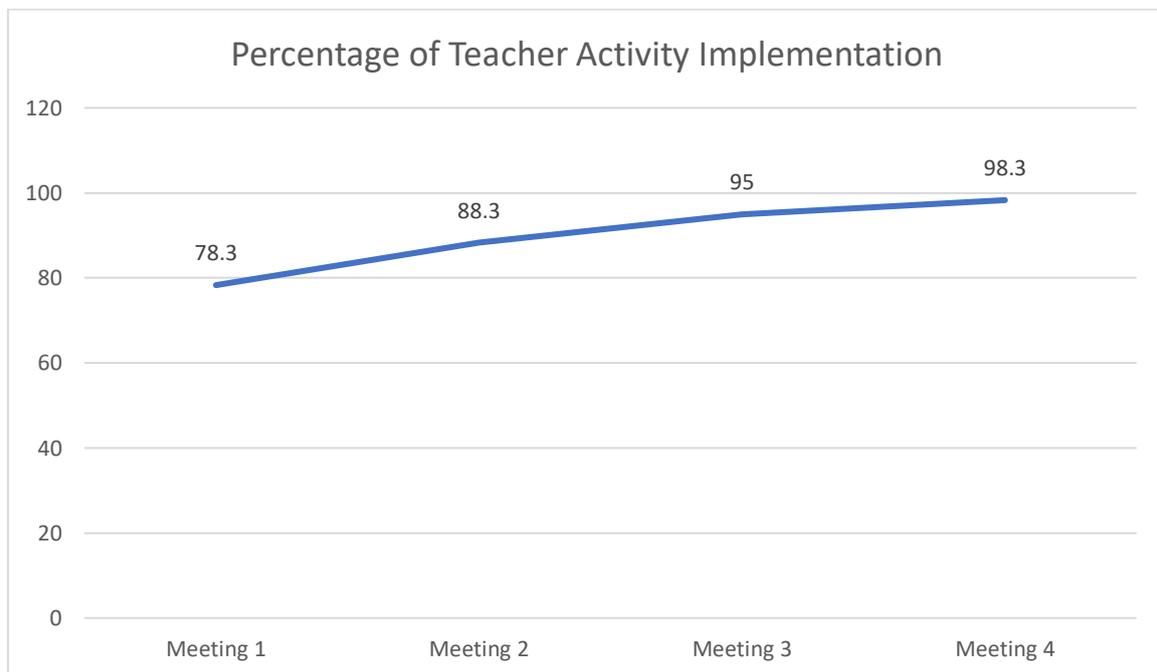
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After implementing the learning activities in each phase of the Deeper Learning Cycle (DELIC) model supported by ProProfs, the overall recapitulation results for each meeting conducted by the researcher are presented as follows:

**Table 2. Teacher Activity Recapitulation Results**

Meeting	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Total	Max Score	%	Information
1	13	7	7	11	9	47	60	78,3	Good
2	13	9	8	13	10	53	60	88,3	Very Good
3	15	9	9	14	10	57	60	95	Very Good
4	15	10	10	14	10	59	60	98,3	Very Good
	Mean					54,2	60	89,9	Very Good

Table 2 shows the total recapitulation for each phase implemented in every meeting. In meeting 1, the percentage reached 78.3% with a “good” category. In meeting 2, it increased to 88.3%, categorized as “very good.” In meeting 3, the percentage further improved to 95%, also classified as “very good,” and in meeting 4, it increased again to 89.9%.



**Figure 2. Recapitulation Results of Teacher Activities Every Meeting**

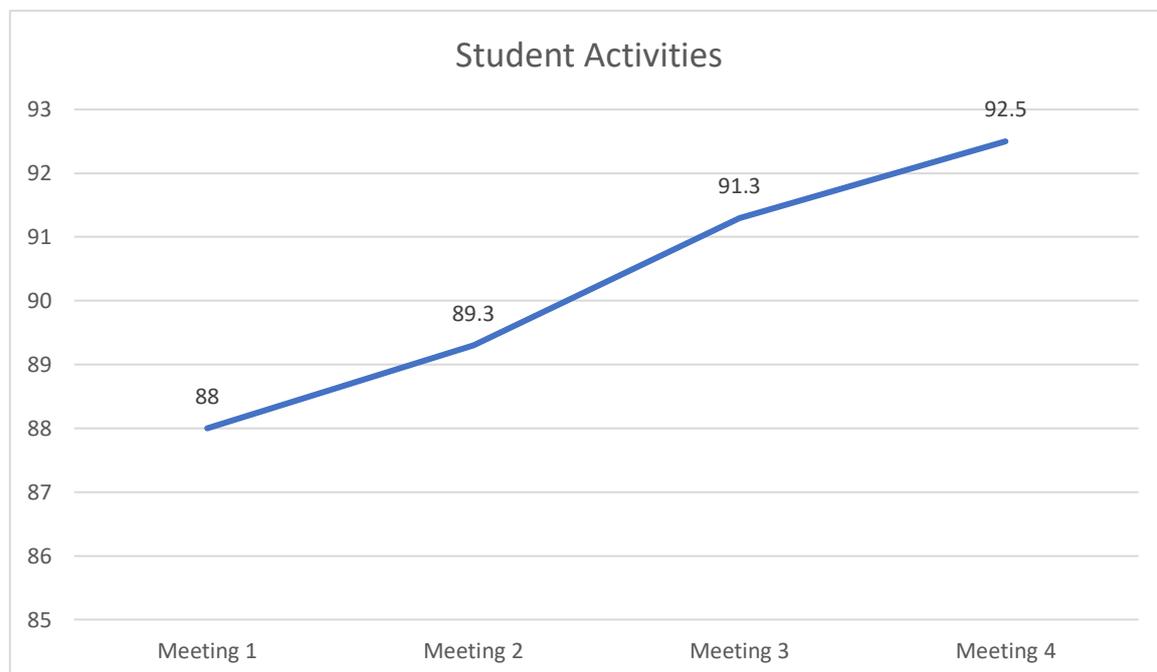
Figure 2 shows a significant improvement in the implementation of teacher activities during the Deeper Learning Cycle (DELIC) learning supported by ProProfs from meeting 1 to meeting 4, indicating a very good level of implementation.

After reviewing the recapitulation of each activity in the Deeper Learning Cycle (DELIC) learning process, the overall recapitulation results of student observation at each meeting conducted by the researcher are presented as follows:

**Table 3. Recapitulation Results of Student Activities**

Meeting	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Total	Max Score	%	Information
1	249	169	187	279	172	1056	1200	88	Very Good
2	257	173	190	275	177	1072	1200	89,3	Very Good
3	261	179	190	279	187	1096	1200	91,3	Very Good
4	269	184	192	276	190	1111	1200	92,5	Very Good
			Mean			1083,7	1200	90,3	Very Good

Table 3 presents the total recapitulation of each activity phase implemented in every meeting. Meeting 1 achieved a percentage of 88%, meeting 2 reached 89.3%, meeting 3 obtained 91.3%, and meeting 4 achieved 92.5%, all categorized as “Very Good.” These results indicate a significant improvement across each meeting. The overall average across all meetings falls within the “Very Good” category, with a percentage of 90.3%.

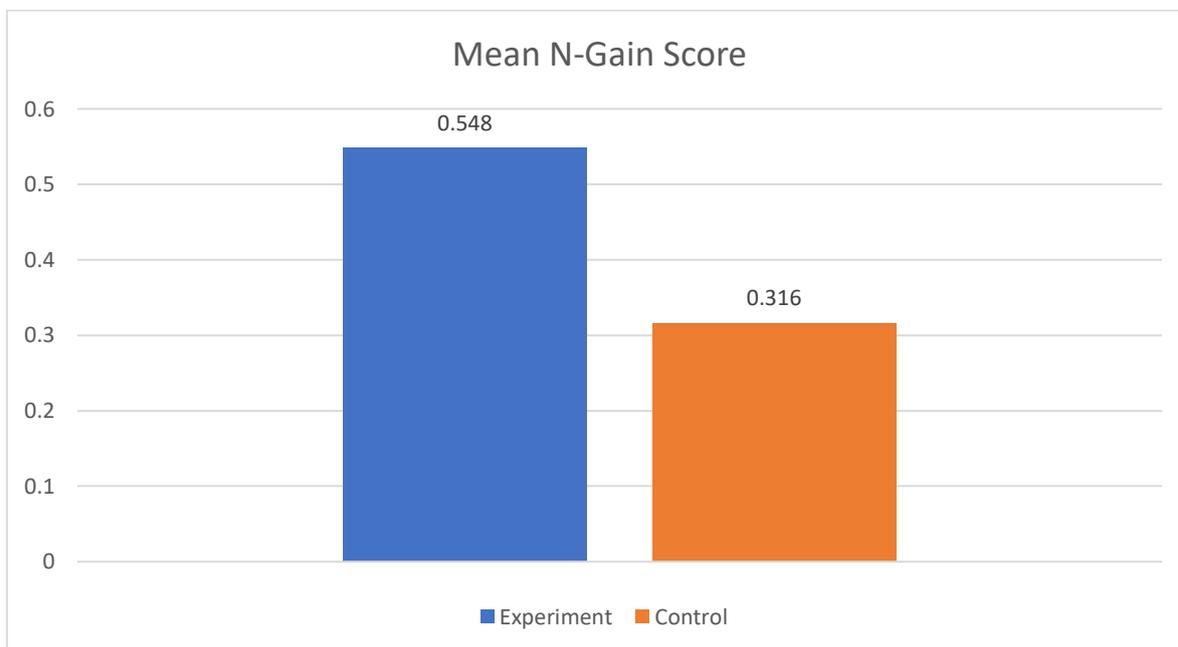


**Figure 3. Recapitulation Results of Student Activities Every Meeting**

Figure 3 shows an improvement in the implementation of student activities from meeting 1 to meeting 4, indicating a very good level of implementation.

### Increasing Mathematical Understanding Ability

Students who participated in the Deeper Learning Cycle (DELIC) supported by the ProProfs application (experimental class) and those who received conventional learning (control class) both showed improvements in their mathematical understanding abilities. The increase in mathematical understanding is illustrated by the N-Gain data. The data used to determine the improvement were obtained from the pretest and posttest results conducted in both the control and experimental classes.



**Figure 4. Mean N-Gain Score**

It can be seen that the average N-Gain score in the experimental class is higher than the average N-Gain score in the control class. Therefore, it can be concluded that the average N-Gain score of the experimental class is better than that of the control class. Data analysis began with prerequisite assumption testing, which included normality and homogeneity tests. After both assumptions were fulfilled, an independent sample t-test was conducted to compare the improvement in learning outcomes between the experimental class—taught using the Deeper Learning Cycle (DELIC) model assisted by ProProfs—and the control class that received conventional instruction. The results of the independent t-test for both classes are presented in Table 2.

**Table 2. N-Gain Data Independent t-test  
Group Statistics**

	Class	N	Mean	Std. Deviation	Std. Error Mean
N_gain	Eksperimen	20	.5481	.14984	.03351
	Control	27	.3158	.12518	.02409

The results of the independent sample t-test conducted using Microsoft Excel are presented in the following table. The table compares the experimental and control classes to identify differences in the improvement of students' mathematical understanding following the implementation of the Deeper Learning Cycle (DELC) model assisted by ProProfs..

**Table 4. Independent t-test Results**

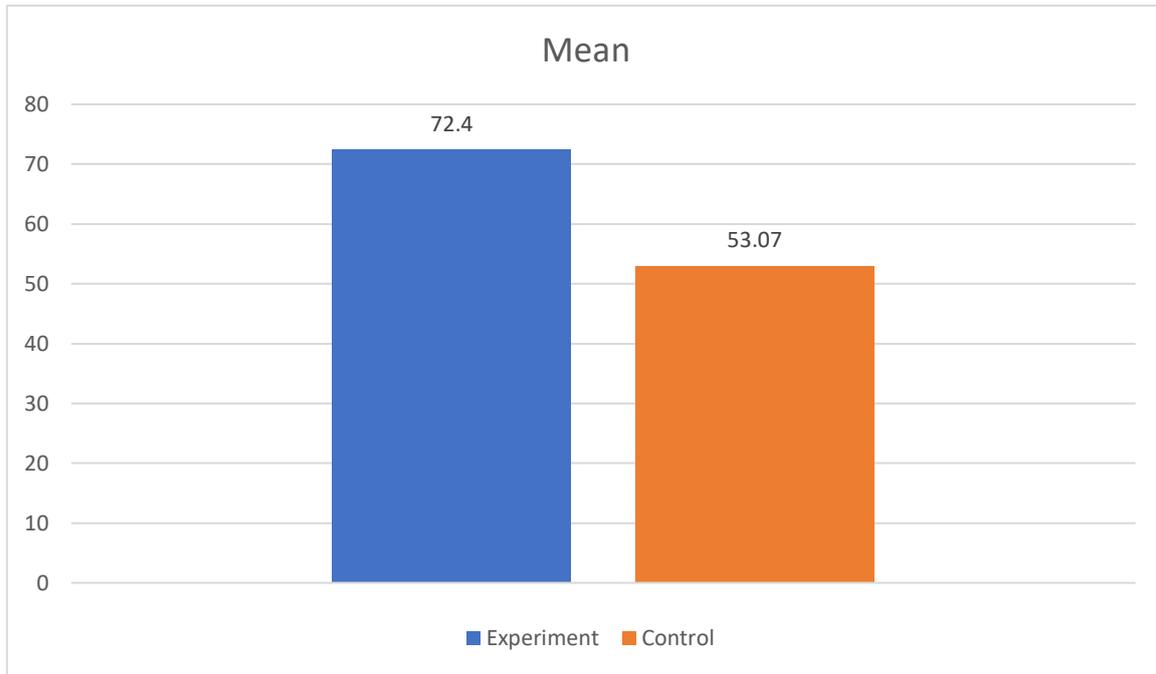
$T_{count}$	$T_{table}$	Information
5,783	1,679	Better

The t-test results in Table 4 show that the value of ( $T_{count}$ ) (5.783) is greater than ( $T_{table}$ ) (1.679), so that  $H_0$  is rejected and  $H_1$  is accepted. At a significance level of 5%, the average N-Gain score for the experimental class (0.548) was significantly higher than the control class (0.316). This shows that Deeper Learning Cycle (DELC) learning assisted by ProProfs provides a better improvement in students' mathematical understanding abilities compared to conventional learning.

In addition, the average N-Gain score for the experimental class was 0.5481, while the control class obtained an average of 0.3158, with both categorized as moderate. Nevertheless, the higher improvement observed in the experimental class indicates that the Deeper Learning Cycle (DELC) model assisted by ProProfs is more effective in enhancing students' mathematical understanding.

#### **Acquisition of Mathematical Understanding Ability**

As shown in Figure 4, the average posttest score of the experimental class is 72.4, while the average posttest score of the control class is 53.07. This indicates that the average score of the experimental class is higher than that of the control class.



**Figure 5. Mean Posttest Mathematical Comprehension Ability**

The research data includes the implementation of prerequisite tests consisting of normality tests and homogeneity tests. After the two assumption tests (normality and homogeneity tests) are fulfilled, an independent t-test is carried out with the help of SPSS and the output is obtained as follows:

**Table 5. Posttest Data Independent t-test Group Statistics**

	Class	N	Mean	Std. Deviation	Std. Error Mean
Posttest	Experimen	20	72.450	11.491	2.570
	Kontrol	27	53.074	11.087	2.134

The outcomes of the independent samples t-test processed through Microsoft Excel are summarized in the table below. The table outlines a comparison between the experimental and control groups to determine the extent of differences in students' mathematical understanding following the application of the Deeper Learning Cycle (DELIC) model supported by ProProfs:

**Table 6. Independent t-test Results**

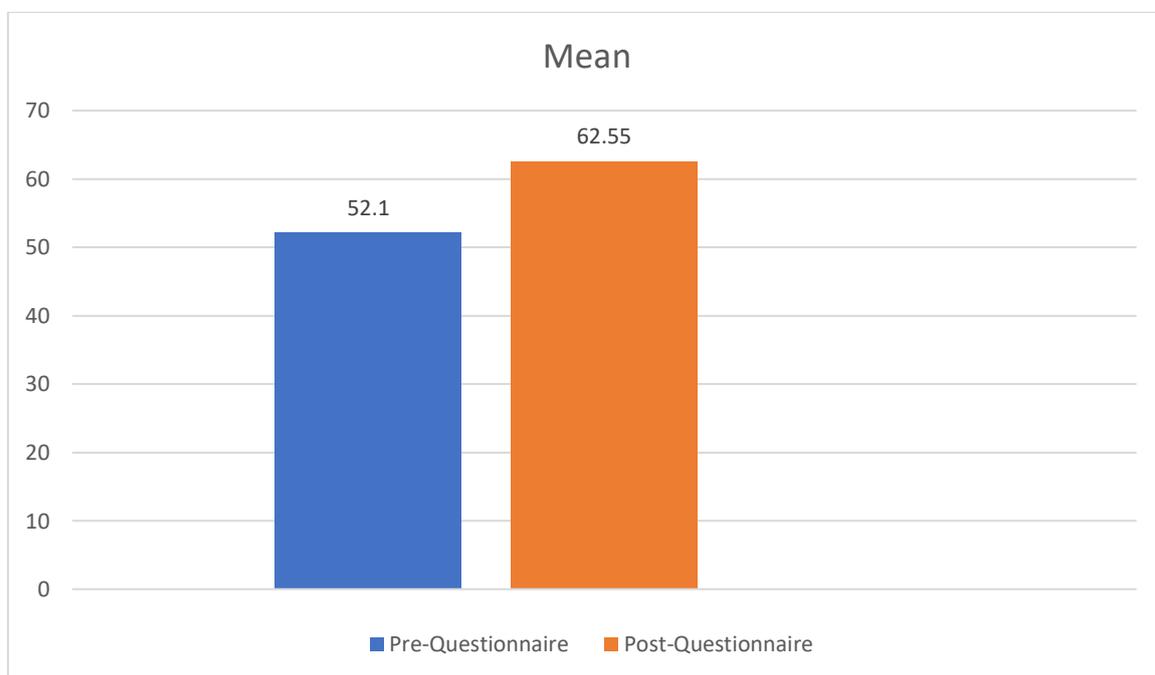
Model	Mean	St. Deviation	$T_{Count}$	$T_{Table}$	Information
Deeper Learning Cycle (DELIC)	72,450	11,491	5,835	1,679	Better
Conventional	53,074	11,086			

The t-test results in Table 4 show that the value of ( $T_{count}$ ) (5.835) is greater than ( $T_{table}$ ) (1.679), so that  $H_0$  is rejected and  $H_1$  is accepted. At a significance level of 5%, the average posttest score for the experimental class (72.450) was significantly higher than the control class (53.074). This means that Deeper Learning Cycle (DELC) learning assisted by ProProfs is able to produce better mathematical understanding abilities than conventional learning.

Furthermore, the mean posttest scores for both the experimental class (72.450) and the control class (53.074) fall within the moderate category. However, the difference between these scores indicates that the implementation of the Deeper Learning Cycle (DELC) model supported by ProProfs is more effective in enhancing students' mathematical understanding.

### Differences in Mathematical Self-Curiousness before and after learning

The results of the pre-questionnaire showed that the highest score obtained was 83.75, while the lowest score was 50. Meanwhile, the post-questionnaire results indicated that the highest score was 95 and the lowest score was 61.25.



**Figure 6. Mean Scores of the Mathematical Curiosity Questionnaire**

Figure 6 shows the average scores obtained from the pre-questionnaire and post-questionnaire in the experimental class. The diagram indicates an improvement from the pre-questionnaire to the post-questionnaire. The post-questionnaire results are significantly better than the pre-questionnaire results of the students in the experimental class.

To determine the increase in students' mathematical curiosity before and after implementing the Deeper Learning Cycle (DELIC) learning model, an analysis of the mathematical curiosity questionnaire was carried out using a Likert scale. This questionnaire was developed based on curiosity indicators and consisted of 20 statements, comprising 10 positive and 10 negative items, which were administered exclusively to the experimental class. The analysis of the increase in students' curiosity was conducted using a paired sample t-test. Prior to performing the test, the attitude scale data were converted from ordinal to interval form using the Method of Successive Intervals (MSI) with the assistance of Microsoft Excel. After confirming that the assumption of normality was met, the data analysis proceeded with the paired sample t-test. The results of the paired t-test, calculated using the Data Analysis tool in Microsoft Excel, are presented in Table 7.

<b>T Count</b>	<b>T Table</b>
3,31	1,67

Based on the table above, the ( $T_{count}$ ) value is 3.31 which is greater than the ( $T_{table}$ ) of 1.67. Thus,  $H_0$  is rejected and  $H_1$  is accepted. This shows that there is a significant difference in the level of students' mathematical curiosity before and after implementing Deeper Learning Cycle (DELIC) learning assisted by ProProfs. In other words, the application of this learning model is able to have a positive influence on increasing students' curiosity in learning mathematics.

## CONCLUSION

The research results show that the application of the Deeper Learning Cycle (DELIC) learning model assisted by ProProfs at MTs Mathla'ul Huda provides high effectiveness in improving students' mathematical understanding and curiosity. During the learning process, both teacher and student activities were in the very good category. Learning using the DELIC model assisted by ProProfs has also been proven to result in improvements and achievements in mathematical understanding abilities that are superior to conventional learning. Apart from that, students' mathematical curiosity also experienced a significant increase after learning, as shown by an increase in questionnaire scores from an average of 52.1 to 62.55. These findings indicate that the application of the Deeper Learning Cycle (DELIC) model assisted by ProProfs is able to create more effective and interesting mathematics learning.

Based on the results of the research and discussions that have been carried out, there are several recommendations that can be taken into consideration for developing learning in

the future. For teachers and researchers who will apply the Deeper Learning Cycle (DELC) model assisted by ProProfs, it is recommended to prepare all learning components optimally, including teaching tools, supporting media, and classroom management strategies. Apart from that, it is necessary to pay attention to time allocation and student conditions so that the learning process can take place optimally and produce maximum learning outcomes.

Furthermore, for researchers who will continue similar studies, it is recommended to explore the application of the Deeper Learning Cycle (DELC) model assisted by ProProfs to other cognitive aspects beyond mathematical understanding abilities, such as reasoning abilities, problem solving, or mathematical communication. Further research can also be conducted at different educational levels to expand the scope and validity of the results.

Finally, continued development of the Deeper Learning Cycle (DELC) model is highly recommended, especially by utilizing other digital applications that are more relevant and contextual according to the mathematical material provided. This approach is expected to make mathematics learning more interesting, flexible, and in line with students' needs and characteristics.

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