

Mathematical Representation and Self Confidence in Trigonometry: The Impact of Student Facilitator and Explaining Learning Model

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Abstract:

Mathematical representation and self confidence play important roles in helping students develop conceptual understanding and solve mathematical problems effectively. Therefore, a learning model that facilitates interaction, communication, and active student participation is needed to optimize both of these competencies. This study aims to determine the effectiveness of the Student Facilitator and Explaining learning model on students' self confidence and mathematical representation ability. This research uses an experimental approach. The research design used was a quasi experimental design with a posttest only control design. The research data were collected through a mathematical representation ability test and a self-confidence questionnaire, and were subsequently analyzed using a normality test, a homogeneity test, and an independent sample t-test. The results indicated that the posttest scores for mathematical representation ability and the self confidence questionnaire scores in the experimental class were higher than those in the control class. These findings suggest that students who participated in learning through the student facilitator and explaining model demonstrated better self-confidence and mathematical representation ability than those who received conventional instruction. Therefore, the student facilitator and explaining learning model is effective in improving students' self-confidence and mathematical representation ability.

Abstrak:

Representasi matematis dan self confidence berperan penting dalam membantu siswa membangun pemahaman konseptual dan menyelesaikan masalah matematika secara efektif, sehingga diperlukan model pembelajaran yang dapat memfasilitasi interaksi, komunikasi, dan partisipasi aktif siswa untuk mengoptimalkan kedua kemampuan tersebut. Penelitian ini bertujuan untuk mengetahui keefektifan model pembelajaran Student Facilitator and Explaining terhadap self confidence dan kemampuan representasi matematis siswa. Penelitian ini merupakan penelitian eksperimen. Desain penelitian yang digunakan adalah quasi experimental design dengan bentuk posttest only control design. Data penelitian diperoleh melalui tes kemampuan representasi matematis dan angket self confidence, kemudian dianalisis menggunakan uji normalitas, uji homogenitas, dan uji t, yaitu Independent samples t-test. Hasil penelitian menunjukkan bahwa skor posttest kemampuan representasi matematis dan

skor angket self confidence pada kelas eksperimen lebih tinggi dibandingkan kelas kontrol. Temuan ini mengindikasikan bahwa siswa yang mengikuti pembelajaran dengan model student facilitator and explaining memiliki self confidence dan kemampuan representasi matematis yang lebih baik dibandingkan siswa yang mengikuti pembelajaran konvensional. Oleh karena itu, model pembelajaran student facilitator and explaining efektif dalam meningkatkan self-confidence dan kemampuan representasi matematis peserta didik.

Keywords:

Mathematical Representation Skills, Self Confidence, Student Facilitator, Explaining, Trigonometry

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INTRODUCTION

Trends in the International Mathematics and Science Study (TIMSS) data from a global assessment of 4th and 8th graders show that in the cognitive domains of Applying and Reasoning which rely heavily on students' ability to create visual or symbolic representations the international average scores often fall short of the target standards. During observations of 10th-grade students at SMAN 3 Salatiga, it was found that students did not feel confident enough to answer questions or explain concepts in front of the class. This was supported by classroom observations and observation sheets, based on a survey conducted by having 10th grade students fill out a form, which indicated that 43.3% of students frequently felt anxious or lacked confidence, while 50% of students sometimes felt a lack of confidence. Additionally, students lacked confidence in their own abilities, particularly regarding trigonometry. Survey results confirm that 40% of students found trigonometry material difficult. The fact that students struggled with trigonometry material resulted in their inability to fully grasp the subject, preventing them from explaining or demonstrating the material to peers or in front of the class. During classroom observations, the teacher dominated the learning process, with some students merely listening and following the teacher's instructions. This does not align with the learning standards of the Merdeka Curriculum, which emphasizes student centered instructional activities designed to actively engage students in the learning process. These findings are consistent with the research

by Ramadhan and Aini (2021) which revealed students' low mathematical representation skills in the area of symbols. Similarly, Mulyadi and Fiangga (2022) noted that students' representation skills remain at a moderate level due to the failure to meet visual representation indicators.

However, these field observations contradict the ideal conditions for mathematics learning. Deep mathematics learning encourages students to communicate or explain the material in their own words, a process commonly known as representation. Mathematical representation involves communicating thoughts or concepts in solving mathematical problems (Mahendra, Mulyono, & Isnarto, 2019). A study by Mpalami and Moleko (2022) shows that mathematical representation is crucial in mathematics learning because it is one of the five essential skills students must possess. Mathematical representation skills are essential for creating inclusive and effective learning in challenging school environments, such as overcrowded classrooms and those with limited facilities. The ability to select and use multiple representations (such as using paper money replicas for addition operations) has been shown to increase students' active participation, clarify abstract concepts, and serve as a scaffolding tool that reinforces students' thinking strategies. In line with research by Sanchez-Ossa, Velazquez, and Rodriguez-Nieto (2025), representations are not merely visual aids at first glance, but fundamental cognitive tools for understanding visualization concepts and solving challenging non routine problems. Through various inspection heuristics such as object decomposition and symbolic demarcation representations have proven effective in bridging abstract conceptual understanding. In addition to mathematical representation skills, self-confidence is a crucial dimension in learning. Self confidence is the belief in one's personal potential that enables a person to take bold steps without anxiety, freely explore their interests, and be prepared to accept the consequences of their decisions (Andayani & Amir, 2019). Research by Bhuvaneswari, Devi, and Lakshmi (2026) confirms that high self confidence not only fosters positive emotional engagement and learning satisfaction but also enhances students' problem solving skills and clinical decision-making abilities. Ultimately, fostering self confidence in the learning process is essential for developing professional competence. The Merdeka Curriculum encourages active and participatory learning, where student self-confidence is a determining factor in learning success. Self confidence acts as a mediator that strengthens the positive impact of freedom in the learning process on student well being. Syam and Amri (2017) argue that self-confidence is an

important personality trait for every individual. A lack of self confidence risks triggering various personal challenges. In fact, self confidence serves as a fundamental foundation for optimizing potential and achieving academic success. Students who possess self confidence tend to be more willing to express their opinions, are active in the learning process, and do not give up easily when facing challenges. Additionally, self confidence helps students build healthy social relationships and enables them to make decisions more independently.

Although numerous studies have been conducted on the Student Facilitator and Explaining learning model, there remains a significant research gap in the specific context of SMAN 3 Salatiga. The majority of previous studies have tended to focus on general cognitive learning outcomes without simultaneously integrating affective and psychomotor aspects into highly complex material such as trigonometry. There is an inconsistency in findings regarding the extent to which students' roles as facilitators can effectively boost self-confidence amidst the challenges of abstract trigonometry material. Additionally, the mathematical representation abilities of 10th-grade students at this school are reportedly still limited to symbolic forms, while the effectiveness of the SFE in stimulating visual and verbal representations has not yet been empirically tested there. This gap highlights the need for in-depth research to determine whether SFE syntax can bridge students' psychological and conceptual barriers and contribute to the development of more inclusive, student-centered mathematics learning strategies at the high school level.

Based on the above discussion, the solution that can be offered is to encourage students to frequently engage in discussions to solve problems. Through discussion, students will be trained to think creatively and more deeply, enabling them to independently grasp the concepts of the material being studied. Additionally, peer-to-peer discussions will encourage students' active participation in learning activities. After independently understanding these concepts, students tend to feel more confident in answering questions or explaining the material to their classmates. The solution proposed above aligns with the Student Facilitator and Explaining (SFE) learning model. The structure of this learning model encourages active student discussion to practice expressing opinions as an indicator of self-confidence. Furthermore, the SFE model encourages students to understand concepts independently so that they can represent mathematical problems using their own understanding. This is consistent with research by Masitoh, Gofur, and Hanum (2025), which demonstrates that the SFE model has a positive impact on students'

mathematical representation skills and self-confidence. In practice, the SFE learning model serves as a platform for students to share perspectives and ideas. This model positions students as facilitators and presenters of learning material through specific stages. This explanation confirms that the Student Facilitator and Explaining instructional model emphasizes student independence and active participation during the learning process. Based on the above discussion, a study will be conducted to determine whether the Student Facilitator and Explaining instructional model is effective in enhancing students' self-confidence and mathematical representation skills in trigonometry for 10th grade students at SMAN 3 Salatiga.

METHODS

This study is a quantitative study that employs an experimental method. An experimental research method is a research approach based on the presence of variables, in which the dependent variable (the one being studied) is determined by manipulating it through the application of treatments (Purnomo, 2015). The research design used is a quasi experimental design in the form of a posttest only control design. The population was confirmed to have equivalent abilities through an initial ability test. After the initial ability test confirmed that the population shared equivalent characteristics, a sample was selected using random sampling. The sample was divided into two groups: the experimental class, which would receive the student facilitator and explaining learning model treatment, and the control class, which would not receive the treatment (conventional learning). Both classes will then take a posttest to measure the difference in their results. The population in this study consists of all 10th-grade students at SMA Negeri 3 Salatiga. The research sample consisted of Class X-7, with 36 students serving as the experimental group, and Class X-12, with 35 students serving as the control group, selected using a random sampling technique. The experimental class used the SFE learning model for three sessions, followed by one session for the posttest and questionnaire. The implementation procedure followed the SFE learning model protocol, which included the teacher stating the learning objectives, presenting an overview of the material, guiding students in forming groups and facilitating the discussion process, allowing students to present their discussion results and explain them to their peers, summarizing students' ideas and reinforcing the entire material, and finally, conducting a learning evaluation and concluding the lesson. The first session of the experimental class began with introductions and an

announcement that the course would run for the next four sessions. The researcher engaged the students in a brief conversation to break the ice. The students appeared shy and awkward since it was their first session. The lesson then proceeded according to the lesson plan, which focused on the SFE learning model syntax with the subject matter of trigonometric ratios in right triangles. The second and third sessions were also conducted more or less in accordance with the lesson plan.

Data collection was conducted using tests and questionnaires. Susanto (2023) states that a test is a tool used for measurement, specifically to gather information about the characteristics of an object. The test used in this study was a posttest consisting of six essay items designed to measure students' mathematical representation skills. There are three indicators of mathematical representation: visual representation, symbolic representation, and verbal representation. Visual representation involves presenting information from one representation to another in the form of images, diagrams, tables, or graphs, and using visual representations to solve problems. Symbolic representation involves creating mathematical equations or models from other given representations and solving problems involving mathematical expressions. Verbal representation involves writing down the steps to solve mathematical problems in words and answering questions using words or written text. The questionnaire consists of closed-ended questions, which provide a series of questions along with answer choices that respondents can select directly. In this study, a questionnaire in the form of a Likert scale was used to measure students' self confidence. Hendriana, Rohaeti, and Sumarmo (2017) outlined four indicators for measuring self confidence: belief in one's own abilities, acting independently in decision making, having a positive self concept, and being bold in expressing opinions.

The instrument was pilot tested on 33 students in Class XI-7, followed by tests of validity, reliability, difficulty level, and item discrimination. The validity test was conducted using the product-moment correlation formula. According to Ananda and Fadhli (2018), a test item is considered valid if $r_{value} \geq r_{table}$ with $\alpha = 5\%$. A total of 33 students took the pilot test. Therefore, referring to the product-moment correlation table, the value of $r_{table} = r_{(n)} = r_{(33)} = 0.344$. The results of the posttest validity test indicated that six essay questions were valid. The questionnaire contained two invalid questions. These two questions were then removed, and the remaining eighteen questions were retested, resulting in all questions being valid. The posttest reliability coefficient is 0.725, and the

questionnaire reliability coefficient is 0.86. The reliability test indicated that the test instrument and questionnaire were reliable, as their reliability coefficients with Cronbach's Alpha were greater than 0.7. According to Darmawan, Permanasari, and Sanjaya (2026), an instrument is considered reliable if its reliability coefficient is greater than or equal to 0.7. Furthermore, the difficulty level test results showed that two questions were of moderate difficulty, two were easy, and two were difficult. The final step in the item discrimination test indicated that the questions were adequate, good, and very good. Consequently, once the instruments are deemed suitable, they can be used for research. To test the population and determine the sample, tests for normality, homogeneity, and equality of means are conducted to ensure that students start from the same baseline ability. Then, for the final stage of testing, tests for normality, homogeneity, and differences in means are used.

RESULTS AND DISCUSSION

The final stage of testing, which tests for normality, homogeneity, and differences in means, is used.

1. Normality Test

A normality test using the Lilliefors test is performed to determine whether the data follows a normal distribution. According to Syafril (2019), in the Lilliefors normality test, the data is said to be normally distributed if $L_{value} < L_{table}$.

Table 1. Results of the Posttest Normality Test

Class	Mean	L_{value}	L_{table}	Criteria
Experiment	77.138	0.0941	0.1478	Normal
Control	66.285	0.1025	0.1497	Normal

Table 2. Results of the Final Normality Test for the Self Confidence Questionnaire

Class	Mean	L_{value}	L_{table}	Criteria
Experiment	64.305	0.1397	0.1478	Normal
Control	57.628	0.0768	0.1497	Normal

Based on table 1 and table 2, using the Lilliefors test for posttest normality, the L_{value} for the experimental group was 0.0941, and the L_{value} for the control group was 0.1025. Meanwhile, the L_{table} value for 36 students was

0.1478, and for 35 students, the L_{table} value was 0.1497. Since the observed $L_{value} < L_{table}$, it can be concluded that the data are normally distributed. The same applies to the normality test for the questionnaire.

2. Homogeneity Test

A homogeneity test was conducted to determine whether the samples were drawn from populations with the same variance (homogeneous) using the F-test.

Table 3. Results of the Homogeneity Test for the Final Posttest Stage

	Varsians	df
Experimental Class	164.1801587	35
Control Class	281.7394958	34

$$F_{value} = \frac{\text{biggest varsians}}{\text{smallest varsians}} = \frac{281.7394958}{164.1801587} = 1.716$$

Table 4. Results of the Homogeneity Test for the Final of the Self Confidence Questionnaire

	Varsians	df
Experimental Class	99.30396825	35
Control Class	148.2403361	34

$$F_{value} = \frac{\text{biggest varsians}}{\text{smallest varsians}} = \frac{148.2403361}{99.30396825} = 1.492$$

Based on Table 3 and Table 4, the degrees of freedom (df) for the largest variance = $35 - 1 = 34$, the degrees of freedom (df) for the smallest variance = $36 - 1 = 35$, and the significance level is 5%, so $F_{tabel} = F_{(0,05;34:35)} = 1.762$. Since $F_{value} < F_{tabel}$, H_0 is accepted, meaning that the data from the two groups are homogeneous.

3. T-tes

A test of the difference in means is useful for comparing whether the two groups have different final performance levels after the experimental group has received the treatment. The test used is an independent samples t-test with the following hypotheses:

$$H_0 = \mu_1 \leq \mu_2$$

$$H_1 = \mu_1 > \mu_2$$

Table 5. T-test Posttest

	Experiment Class	Control Class
Mean	77.1389	66.2857
Variance	164.1802	281.7395
Observations	36	35
Pooled Variance	222.107948	
Hypothesized Mean Difference	0	
df	69	
SD	12.813	16.544
t Stat	3.067826808	
P(T<=t) one-tail	0.001539834	
t Critical one-tailed	1.667238549	

Based on table 5, the ability to represent mathematical calculations is as follows:

$$t_{value} = \frac{\bar{x}_1 - \bar{x}_2}{S \sqrt{\frac{n_1+n_2}{n_1 \times n_2}}} = \frac{77.14 - 66}{14,9 \sqrt{\frac{36+35}{36 \times 35}}} = 3.067$$

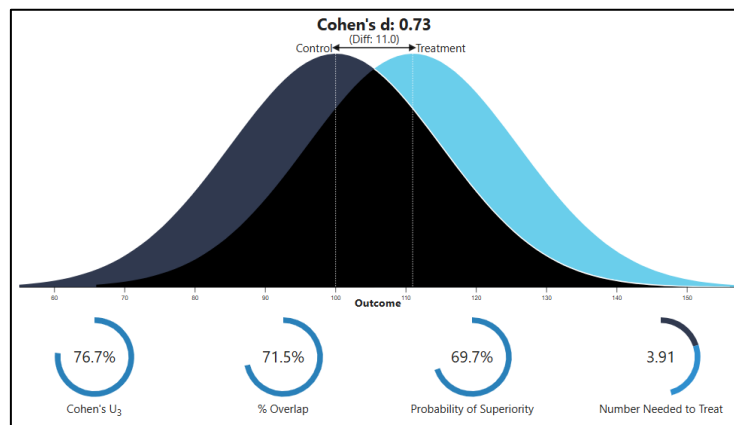


Figure 1. Cohen's d Effect Size

Cohen's d is calculated according to the formula:

$$d = \frac{M_2 - M_1}{\sqrt{\frac{SD_1^2 + SD_2^2}{2}}} = \frac{77.1389 - 66.2857}{\sqrt{\frac{12.813^2 + 16.544^2}{2}}} = \frac{10.853}{14.797} = 0.733 \text{ (medium effect)}$$

Based on figure 1 with a Cohen's d of 0.73, 76.7% of the treatment group will be above the mean of the control group, 71.5% of the two groups will

overlap, and there is a 69.7% chance that a person picked at random from the treatment group will have a higher score than a person picked at random from the control group (Magnusson, 2023).

Table 6. T-test Questionnaire

	Experiment Class	Control Class
Mean	64.056	57.6286
Variance	99.3040	148.2403
Observations	36	35
Pooled Variance	123.4175408	
Hypothesized Mean Difference	0	
df	69	
S	11.109	
t Stat	2.531908447	
P(T<=t) one-tail	0.006812526	
t Critical one-tailed	1.667238549	

Based on table 6 for the self-confidence questionnaire, the calculations are as follows:

$$t_{value} = \frac{\bar{x}_1 - \bar{x}_2}{S \sqrt{\frac{n_1 + n_2}{n_1 \times n_2}}} = \frac{64.31 - 58}{11.109 \sqrt{\frac{36 + 35}{36 \times 35}}} = 2.531$$

Degrees of freedom, then $df = n_1 + n_2 - 2 = 36 + 35 - 2 = 69$. At a 5% significance calculated subscript is $d = t_{(0.05;69)} = 1.667$. Since the calculated subscript is t_{value} is greater than t_{table} , H_0 is rejected and H_1 is accepted, meaning that the experimental class students' mathematical representation skills and self-confidence are superior to those of the control class, as judged by the mean posttest scores.

The results of the data analysis from the self-confidence questionnaire showed that the average score for the experimental class was 64.31 and 58 for the control class. Based on the acceptance of the alternative hypothesis and the fulfillment of the effectiveness criteria, that the average score of the experimental class was higher than that of the control class, it is concluded that the SFE model is effective in enhancing students' self confidence and mathematical representation skills. In the context of these variables, this study aligns with the theory of Carl Rogers, a humanistic psychologist, who believed that an individual's self confidence can motivate them to develop the ability to

perform a task (Surbakti, Widyasana, Siregar, Sinurat, Nasution, Tresna, Lubis, & Nadeak, 2022). Humanistic learning gives students the freedom to express their opinions, so humanistic theory aligns with self-confidence. The SFE learning model provides students with academic freedom to express their opinions and test the originality of their ideas without rigid external pressure (Noviyana, Dewi, & Rochmad, 2019). When students are given the authority to act as facilitators, they feel recognized and valued. This freedom of expression confirms the relevance of humanistic theory in fostering self confidence. According to Maslow's theory, self confidence is the primary foundation for individuals to optimize their potential. Students with strong self-confidence will find it easier to recognize and understand their identity, while low self-confidence actually acts as a barrier to self-development (Alwisol, 2018). This explains why students in the control group tend to be pessimistic, often feel uncertain, and frequently compare their abilities with others when facing problems or making decisions. Through social interaction in the form of meaningful classroom discussions, students feel more valued, and the supportive atmosphere allows their potential to flourish without the fear of failure (Jayanti, Sholikhah, Yahya, Hanum, & Hamidah, 2023). Group discussions serve as a platform for students to exchange ideas about mathematical concepts they find challenging (Hanantaqiya & Pradana, 2025).

The results of the data analysis on the posttest of mathematical representation skills showed that the experimental class achieved an average score of 77.14, while the control class scored 66. The calculation of Cohen's d in this study yielded a value of 0.733, which falls into the category of a medium-to-strong effect. This figure confirms that the intervention or treatment administered produced a sufficiently distinct and practically meaningful difference between the experimental and control groups. From a methodological perspective, these findings demonstrate that the observed difference in means is not merely a statistical coincidence but rather a reflection of the program's actual effectiveness in the field. This moderate effect size of 0.733 makes a significant contribution to the research because it offers a practical, efficient solution with a high probability of success if implemented on a broader scale. This indicates that the experimental class's average score was higher than that of the control class. Based on these results, it can be concluded that the Student Facilitator and Explaining learning model is effective in enhancing mathematical representation skills. These findings align with Jean Piaget's constructivist theory, which asserts that knowledge is independently

constructed by individuals through active interaction with their environment, rather than merely passively received (Bustomi, Sukardi, & Astuti, 2024). This theory draws on the discipline of psychology, particularly Piaget's cognitive psychology, which addresses the psychological mechanisms driving the formation of knowledge (Wahab & Rosnawati, 2021). The SFE model inherently changes classroom dynamics by positioning students as facilitators tasked with re-explaining the material to their peers. This process of facilitating and explaining is not merely a speaking activity, but rather a high level cognitive process that compels students to reconstruct their own mathematical understanding. When a student prepares to explain a concept, they must transform abstract mathematical ideas into a more concrete form that others can understand whether through verbal, visual (graphs/diagrams), or symbolic (mathematical equations) representations. This activity strengthens students' multi-representational skills because it requires cognitive flexibility in translating one form of representation into another. In line with these findings, Hamdayama (2016) states that the learning process is viewed as the independent construction of knowledge by students, manifested through active engagement in activities, critical thinking, concept formation, and the attribution of meaning to the material being studied. Knowledge is formed through representational abilities, specifically by applying visual, verbal, and symbolic representations during the learning process, particularly when working on worksheets and engaging in discussions through student presentations.

This study demonstrates the independent linear effectiveness of the SFE model in addressing students' difficulties with trigonometry material in Grade 10 at SMAN 3 Salatiga, specifically regarding mathematical representation skills and self confidence. Meanwhile, Siregar, Azis, and Amri (2022) findings at the seventh grade level provide a comparative dimension by demonstrating through an analysis of covariance (ancova) that the SFE model, along with the reciprocal teaching model, has equivalent effectiveness in influencing both dependent variables, with neither model dominating absolutely.

CONCLUSION

Based on the acceptance of the alternative hypothesis and the fulfillment of the effectiveness criteria namely, that the average score of the experimental class was higher than that of the control class it is concluded that the SFE model is effective in enhancing students' self confidence and mathematical

representation skills. It was also observed that students were more confident when asked to explain something in front of their classmates, and they began to demonstrate strong mathematical reasoning skills during the learning process. The SFE learning model has a positive impact on mathematical representation skills and self-confidence because it encourages students to take an active role as facilitators and explainers of the material to their classmates, which boosts their confidence in expressing their opinions and understanding the subject matter. Cohen's d effect size of 0.733 also demonstrates that the instructional model implemented in the experimental class had a fairly significant effect on learning. The SFE model requires students to be directly involved in the process of presenting material, so that they become accustomed to speaking in public and interacting with their peers. Thus, it can be concluded that the implementation of the Student Facilitator and Explaining learning model is effective in enhancing students' self-confidence and mathematical representation skills in the 10th-grade trigonometry material at SMAN 3 Salatiga. The researchers have made every effort to conduct this study to the best of their ability. However, they recognize that there are still some unavoidable shortcomings, resulting in limitations regarding the location, time, and research subjects. This study was conducted at a single research site, namely SMAN 3 Salatiga, during the even semester of the 2025/2026 academic year. Furthermore, this study only explored the Student Facilitator and Explaining (SFE) learning model as the independent variable and the dependent variables, which include mathematical representation skills and self confidence in trigonometry. Future research is advised to integrate the SFE learning model with digital technology to examine its impact on students' mathematical representation skills in a more adaptive manner. Subsequent researchers should also deeply explore how social interaction within SFE based assessment can influence students' psychological factors, particularly in regulating math anxiety to foster more robust and sustainable self confidence.

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- Author Contribution : FQP: Conceptualization, Methodology, Instrument Development, Data Collection, Data Analysis, Writing-Original Draft, Writing-Review & Editing, and Supervision.
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