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Math Communication Growth through Two Stay Two Stray Approch

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Abstrak

Kemampuan komunikasi matematika siswa masih sangat rendah. Penelitian ini bertujuan untuk menganalisis pengaruh model pembelajaran Two Stay Two Stray terhadap kemampuan komunikasi matematis siswa kelas XI. Sampel penelitian adalah siswa kelas XI Sains A2 dan A4 yang berjumlah 72 siswa. Metode yang digunakan adalah quasi eksperiment dengan desain penelitian pretest-posttest control group design. Instrumen penelitian berupa lima tes uraian untuk mengukur kemampuan komunikasi matematis. Data dianalisis menggunakan Independent Sample T-Test dengan nilai signifikansi yang diperoleh yaitu 0,000, dari hasil tersebut diketahui bahwa nilai signifikansi 0,000 < 0,05. Adapun nilai effect size sebesar 1,7 yang menunjukkan bahwa terdapat pengaruh model Two Stay Two Stray sebesar 95,5% terhadap kemampuan komunikasi matematis siswa kelas XI. Dengan demikian, dapat disimpulkan bahwa terdapat pengaruh model pembelajaran Two Stay Two Stray terhadap kemampuan komunikasi matematis siswa kelas XI.
Kata Kunci: Kemampuan Komunikasi Matematis; Pengaruh; Two Stay Two Stray

Abstract

Students' mathematical communication ability in schools are still very low. This study aims to analyze the effect of the two stay two stray learning model on the mathematical communication ability of grade XI students. The research sample was 72 grade XI A2 and A4 Science students. The method used was a quasi-experimental study with a pretest-posttest control group design. The research instrument was five essay tests to measure mathematical communication ability. The data were analyzed using the Independent Sample T-Test with a significance value of 0,000, from these results it is known that the significance value of 0,000 < 0,05. The effect size value of 1,7 indicates that there is an influence of the Two Stay Two Stray model of 95,5% on the mathematical communication ability of grade XI students. Thus, it can be concluded that there is an influence of the Two Stay Two Stray learning model on the mathematical communication ability of grade XI students.
Keywords: Mathematical Communication Ability; The Effect; Two Stay Two Stray

I. INTRODUCTION

Mathematics is one of the most important subjects in human life because it is used in everyday life and to develop the human mind (Dewanto et al., 2019; Respati & Qohar, 2021; Sarumaha et al., 2022). Therefore, mathematics is a compulsory subject at all levels of education as a guide in everyday life. (Utami et al., 2021; Turmuzi & Kurniawan, 2021) explains that mathematics learning serves as a medium for developing critical, logical, and creative thinking skills, as well as the collaborative skills needed to face the changing times. Given the crucial role of mathematics, mathematics learning should be presented in an engaging and enjoyable manner to stimulate students' interest and enthusiasm in learning it (Masrukan & Khairunnisa, 2020; Lubis et al., 2024). Providing learning to students by training their ability to use mathematical language to convey ideas or concepts to clarify a problem. According to Septikayanti et al. (2022) and Nurrokhim et al. (2019), mathematics is a language that uses symbols, so anyone who studies it needs mathematical communication ability to use those symbols.

Good mathematical communication ability enable someone to utilize mathematics for personal and other people's benefit, so that mathematics becomes more useful (Ikhsan & Afriansyah, 2023). According to Turmuzi and Kurniawan (2021) and Suwangsih et al. (2019) mathematical communication ability are activities in conveying information, such as messages, ideas, or inspiration, between communicating parties, so that mutual understanding is created regarding the intended meaning. (Diniati et al., 2021; Nurrokhim et al., 2019) stated that communication ability in mathematics play a crucial role in helping students improve their understanding of the material. Every lesson taught to students should help them develop their communication ability, including mathematics. Mathematics instruction is conducted with specific goals and objectives, namely to train students' ability to convey and communicate the results of their thinking through symbols, tables, diagrams, or other learning media in order to clarify existing problems (Suhenda & Munandar, 2023; Linda & Afriansyah, 2022; Suwangsih et al., 2019). So, the importance of students' mathematical communication ability in mathematics education is clear.

However, in reality, students' mathematical communication ability in schools are still very low (Hidayatuloh & Sumartini, 2022; Rahmawati, Cholily, & Zukhrufurrohmah, 2023; Zohriah, Ahyan, & Endriana, 2024). According to Sudiman et al. (2023) and Une et al. (2023), students also still struggle to communicate their thoughts, ideas, and concepts when applying mathematical models, both verbally and in writing. This is influenced by two factors: the questions given are still ordinary or do not support mathematical communication ability, and the learning materials are not yet able to encourage students' high-level mathematical communication ability.

The low level of students' mathematical communication ability is also evident from the results of the initial test conducted by researchers on class XI students at MAN 1 Medan, where students were unable to

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solve problems completely according to the indicators of students' mathematical communication ability. The indicators of mathematical communication ability measured were (Diniati et al., 2021): (1) The ability to connect real objects to mathematical ideas. (2) The ability to express everyday events into mathematical symbols in presenting mathematical ideas in writing. (3) Ability to explain ideas, everyday situations and mathematical relationships, in writing and with drawings. (4) Ability to understand and evaluate mathematical ideas in solving everyday problems in writing. (5) Ability to communicate the conclusion of the answer to everyday problems according to the question.

In an effort to improve students' mathematical communication ability, teachers need to design innovative learning models. Wiratama (2020) and Salamun et al. (2023) said that innovative learning models such as project-based learning, flipped learning, and problem-based learning can help students develop critical thinking, creativity, communication, and collaboration ability. One innovative learning model that can be used is the cooperative learning model. Depends on (Tewu et al., 2024; Masrukan & Khairunnisa, 2020) in cooperative learning, students are more active in learning, thus having a positive impact on the quality of interaction and communication.

Cooperative learning has several types, one of which is Two Stay Two Stray. This cooperative learning model is considered suitable for providing opportunities and encouraging students to practice mathematical communication ability (Suwangsih et al., 2019; Mayasari et al., 2022). TSTS is considered appropriate for providing opportunities and encouraging students to practice their mathematical communication ability. One reason is that TSTS prioritizes group activities in problem-solving. According to (Darmawan & Harjono, 2020; Andani, 2021), Two Stay Two Stray is a learning model designed to foster cooperation, responsibility, mutual assistance in problem-solving, and mutual motivation to achieve. Furthermore, this model also trains students' communication ability. Furthermore, according to (Sekali et al., 2022) One of the efforts to improve students' mathematical communication ability is Two Stay Two Stray, which aims to encourage cooperation, responsibility, mutual assistance in solving problems, and mutual motivation between students.

In its implementation, TSTS has five stages, namely preparation, teacher presentation, group activities, formalization, and evaluation (Taufik, 2021). From the steps of TSTS type cooperative learning, students will be actively involved in interacting and discussing with their friends, so that they can find various ways to express their mathematical ideas (Jamila et al., 2019; Darmawan & Harjono, 2020). This learning model can improve students' mathematical communication ability, because the learning process involves the active participation of all students. Based on this explanation, this study aims to determine the effect of the Two Stay Two Stray learning model on the mathematical

communication ability of class XI students of MAN 1 Medan.

II. METHOD

This type of research is descriptive quantitative research conducted at MAN 1 Medan. The research implementation time was in April 2025. This study used a quasi-experimental research design with a nonequivalent control group design (Sugiyono, 2019).

In this study, the sample was selected using purposive sampling. The sample consisted of two classes: 36 students from Class XI Science A2 as the control class and 36 students from Class XI Science A4 as the experimental class, resulting in a total sample of 72 students.

The instrument used in this study was a test consisting of five descriptive questions to measure students' mathematical communication skills, focusing on the rules of sines and cosines. Prior to developing the mathematical communication ability test, a test outline was created that aligned with the learning indicators and mathematical communication skills indicators, along with solutions and scoring guidelines.

Scoring of students' mathematical communication improvement is based on the "Holistic Scoring Rubric" by Cai, Lani and Jacobsin which was rewritten by (Noviana et al., 2018). After the test grid was developed, instrument testing was conducted to ensure its quality. The research instrument met the specified criteria for validity, reliability, difficulty level, and discriminatory power. Therefore, the instrument for assessing students' mathematical communication skills was deemed suitable for use.

Before data analysis and hypothesis testing, prerequisite tests were conducted, namely the normality and homogeneity tests. Based on the results of the Liliefors (Kolmogorov-Smirnov) test, the initial data were found to be normally distributed, and the homogeneity test indicated that the initial data were homogeneous. Therefore, the Independent Sample T-Test was used to test for differences.

III. RESULT AND DISCUSSION

The results of students' mathematical communication ability are obtained from the results of pretest scores conducted before the provision of learning actions. Students will be grouped based on the level of mathematical communication ability, namely high, medium, and low groups. The Table 1 displays the students' test results on the measurement of their mathematical communication ability.

Table 1.
Grouping Results of Pretest Mathematical Communication Ability

Class	Overall Score Range			
	Scale	Category	Many Students	Percentage
Eksperiment	$X \geq 14$	High	1	2,77%
	$6 < X < 14$	Medium	29	80,56%
	$X < 6$	Low	6	16,67%
Total			36	100%
Control	$X \geq 14$	High	1	2,77%
	$6 < X < 14$	Medium	25	69,45%
	$X < 6$	Low	10	27,78%
Total			36	100%

The results of the mathematical communication ability test were graphed and grouped into high, medium, and low. Based on table 3 in the experimental class,

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it can be seen that out of 36 students, 1 student (2,77%) has high category mathematical communication ability, 29 students (80,56%) have moderate category mathematical communication ability, and 6 students (16,67%) have low category mathematical communication ability. So, from these data it can be concluded that students' mathematical communication abilities are in the medium category with a percentage of 80,56%. This is in line with research (Sarumaha et al., 2022) which states that students who are in the moderate category have not been able to solve mathematical communication ability problems.

Furthermore, in the control class, it can be seen that out of 36 students, 1 student (2,77%) has high communication ability, 25 students (69,45%) have medium communication ability, and 10 students (27,78%) have low communication ability. So, from these data it can be concluded that students' mathematical communication abilities are in the medium category with a percentage of 69,45%. This is in line with research (Sarumaha et al., 2022) which states that students who are in the medium category have not been able to solve mathematical communication ability problems. The results of the student mathematical communication ability test on each indicator in each category, can be seen from the Figure 1.

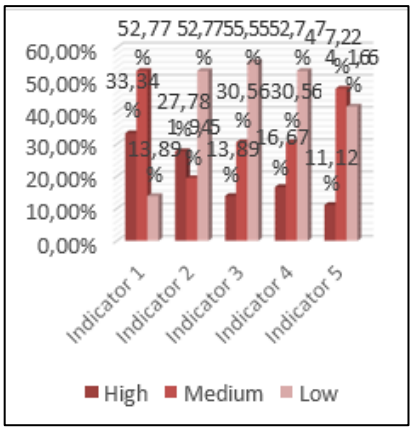

Figure 1. Percentage Pretest in Each Indicator Category of Mathematical Communication Ability of Experimental Class Students.

From Figure 1., it can be seen the percentage of students' mathematical communication abilities on each indicator. Indicator 1 in the high category was 33,34% or 12 students, in the medium category was 52,77% or 19 students, and the low category was 13,89% or 5 students. Indicator 2 in the high category was 27,78% or 10 students, in the medium category was 19,45% or 7 students, and the low category was 52,77% or 19 students%. Indicator 3 in the medium category was 30,58% or 11 students, and the low category was 55,55% or 20 students. Indicator 4 in the high category was 16,67% or 6 students, in the medium category was 30,56% or 11 students, and the low category was 52,77% or 19 students. Indicator 5 in the high category was 11,12% or 4 students, in the medium category was 47,22% or 17 students, and the low categort was 41,66% or 15 students.

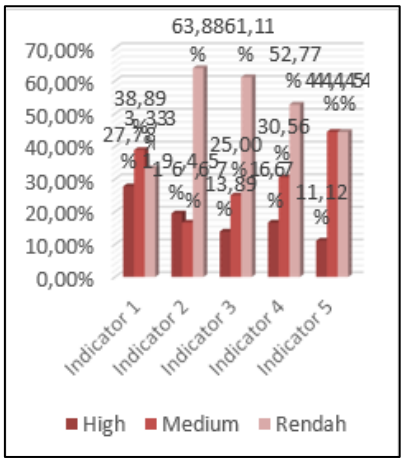

Figure 2. Percentage of Students in Each Indicator Category of Mathematical Communication Ability of Control Class Students.

From Figure 2, it can be seen the percentage of students' mathematical communication abilities on each indicator. Indicator 1 in the high category was 27,78% or 10 students, in the medium category was 38,89% or 14 students, and the low category was 33,33% or 12 students. Indicator 2 in the high category was 19,45% or 7 students, in the medium category was 16,67% or 6 students, and the low category was 63,88% or 23 students. Indicator 3 in the high category was 13,89% or 5 students, in the medium category was 25% or 9 students, and the low category was 61,11% or 22 students. Indicator 4 in the high category was 16.67% or 6 students, in the medium category was 30,56% or 11 students, and the low category was 52,77% or 19 students. Indicator 5 in the high category was 11,12% or 4 students, in the medium category was 44,44% or 16 students, and the low category was 44,44% or 16 students.

After obtaining the results of the students' mathematical communication ability test, the next step is to group the students based on the ability level category, namely high, medium, and low. Table 2 presents details of the students' test results based on their mathematical communication ability level.

Table 2.
Mathematical Communication Ability Posttest Grouping Results

Class	Overall Score Range			
	Scale	Category	Many Students	Percentage
Experiment	$X \geq 14$	High	36	100%
	$6<X<14$	Medium	0	0%
	$X < 6$	Low	0	0%
Total			36	100%
Control	$X \geq 14$	High	15	41,66%
	$6<X< 14$	Medium	21	58,34%
	$X < 6$	Low	0	0%
Total			36	100%

The results of the mathematical communication ability test were graphed and grouped into high, medium, and low. Based on table 4.6 in the experimental class, it can be seen that out of 36 students, 36 students (100%) have high category mathematical communication ability, 0 students (0%) have medium category mathematical communication ability, and 0 students (0%) have low category mathematical communication ability. So, from these data it can be concluded that students' mathematical communication abilities are in the high category with a percentage of 100%. This is in line with research (Ulymaz et al., 2022) that students who are categorized as high in mathematical communication ability, students will be able to master all indicators well, in other words, high categories in the five indicators of mathematical communication ability.

Furthermore, in the control class, it can be seen that out of 36 students, 15 students (41,66%) have high communication ability, 21 students

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(58,34%) have medium communication ability, and 0 students (0%) have low communication ability. So, from these data it can be concluded that students' mathematical communication abilities are in the medium category with a percentage of 58,34%. This is in line with research (Sarumaha et al., 2022) which states that students who are in the moderate category have not been able to solve mathematical communication ability problems. The results of the student mathematical communication ability test on each indicator in each category, where the results can be seen in Figure 3.

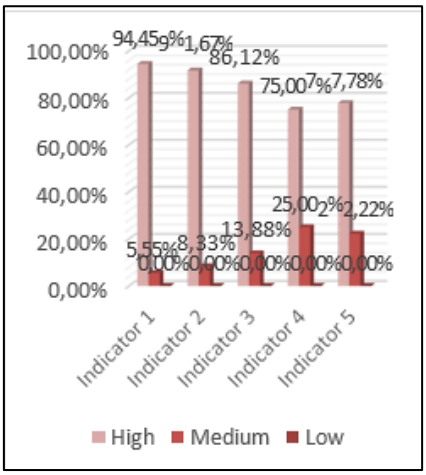

Figure 3. Percentage Posttest in Each Indicator Category of Mathematical Communication Ability of Experimental Class Students.

From Figure 3, it can be seen the percentage of students' mathematical communication ability on each indicator. Indicator 1 in the high category was 94,45% or 34 students and in the medium category was 5,55% or 2 students. Indicator 2 in the high category was 91,67% or 33 students and in the medium category was 8,33% or 3 students. Indicator 3 in the high category was 86,12% or 31 students and in the medium category was 13,88% or 5 students. Indicator 4 in the high category was 75% or 27 students and in the medium category was 25% or 9 students. Indicator 5 in the high category was 77,78% or 28 students and in the medium category was 2,22% or 8 students.

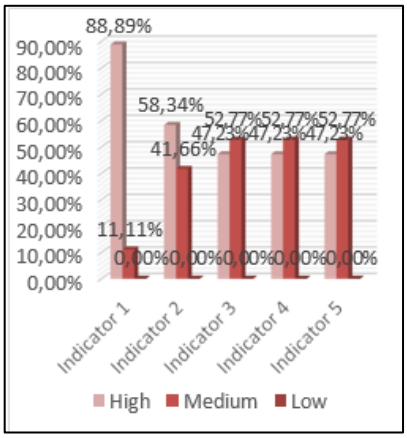

Figure 4. Percentage of Students in Each Indicator Category of Mathematical Communication Ability of Control Class Students.

From Figure 4, it can be seen the percentage of students' mathematical communication ability on each indicator. Indicator 1 in the high category was 88,89% or 32 students and in the medium category was 11,11% or 4 students. Indicator 2 in the high category was 58,34% or 21 students and in the medium category was 41,66% or 15 students. Indicator 3 in the high category was 47,23% or 17 students and in the medium category was 52,77% or 19 students. Indicator 4 in the high category was 47,23% or 17 students and in the medium category was 52,77% or 19 students. Indicator 5 in the high category was 47,23% or 17 students and in the medium category was 52,77% or 19 students.

Furthermore, to analyze the effect of the Two Stay Two Stray learning model on students' mathematical communication ability, the pretest-posttest data were

processed and evaluated using an independent t-test (unpaired). The results of the Independent Sample T-Test analysis processed using the SPSS 21 application showed a 2-tailed significance for the posttest of the experimental and control classes of 0,000. Because 0,000 < 0,05, then based on the testing criteria, H_0 is rejected and H_a is accepted so it can be concluded that mathematical communication ability using the Two Stay Two Stray learning model are better than students taught with the Direct Interaction learning model. This shows that the average posttest of the experimental class is higher than the average of the control class. Similarly, the effect size test results obtained a value of d = 1,7 which means that the Two Stay Two Stray model has an effect of 95,5% on students' mathematical communication ability in 11th grade students of MAN 1 Medan.

From the learning process that has been carried out by researchers, it is identified that there are variations in learning styles between students in experimental and control classes. In the control class, students tended to be passive, only listening to the teacher's explanation and carrying out instructions according to the directions given. Meanwhile, in the experimental class there was active communicative interaction among the students. The stages in the Two Stay Two Stray learning model successfully encouraged and stimulated students to communicate more actively, both within their groups and when responding to other groups. In the initial phase of group division, students were divided into 9 groups with 4 members each. At this stage, mathematical communication ability began to appear when students discussed the material in the worksheet distributed by the teacher with their group members. Communication between students in the group was evident when they exchanged ideas discussing the worksheet. This is in line with research (Awanis & Yusnaldi, 2024) which reveals that learning involving discussion and exchange of ideas between groups provides an opportunity for students to understand various ways of solving problems and gain insight from the perspectives of their peers. Based on the following explanation, it will be more about how influential the Two Stay Two Stray learning model is on students' mathematical communication ability.

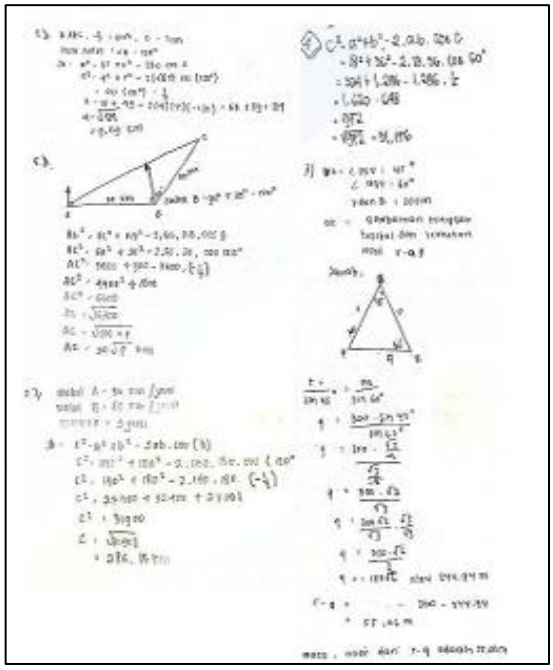

Figure 5. Control Class Posttest Results.

Figure 5 shows that in the first problem, students only wrote the known information and did not write the information asked on the answer sheet. This shows that students are less able to connect real objects, images, and diagrams into mathematical ideas well. This is in line with research

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(Istiani et al., 2019) which shows that students who only write the known part, it can be concluded that the students have not fully understood the problem given and have not been able to develop their mathematical communication completely.

In the second problem, students cannot write mathematical symbols into the problem. This shows that students are not able to express everyday events in mathematical language or symbols in presenting mathematical ideas in writing well. This is in line with research (Sarumaha et al., 2022) which shows that students are unable to state mathematical models in everyday situations that have been presented in the problem.

In the third problem, students can describe the triangle requested in the problem. This is in line with research (Warnawati et al., 2023) that students can express problems in the form of images properly and correctly. This shows that students are able to explain everyday ideas and situations and in writing with pictures.

In the fourth problem, students are unable to understand the problems in the problem and do not write the steps on the answer sheet completely. This shows that students are not able to understand and evaluate mathematical ideas in solving everyday problems well in writing. This is in line with research (Diniati et al., 2021) which shows that students do not answer completely with the right explanation.

In the fifth problem, students cannot write conclusions even though students provide the final answer. This is in line with research (Sarumaha et al., 2022) that students only focus on trying to get answers to the problems they do, students are unable to provide a final statement as a conclusion to the answers that have been obtained using their own language.

Based on the pretest results of the control class, it was found that students' mathematical communication skills were still low. This is in line with research (Fitriani et al., 2022) which found that students with low mathematical communication ability were unable to use mathematical symbols appropriately and meaningfully. This is due to students' lack of conceptual mastery and understanding of the material. A strong conceptual mastery and understanding of the material would enable them to understand problems and use symbols to solve them (Sarumaha et al., 2022).

Next, we will explain the posttest results of the experimental class based on the measured indicators.

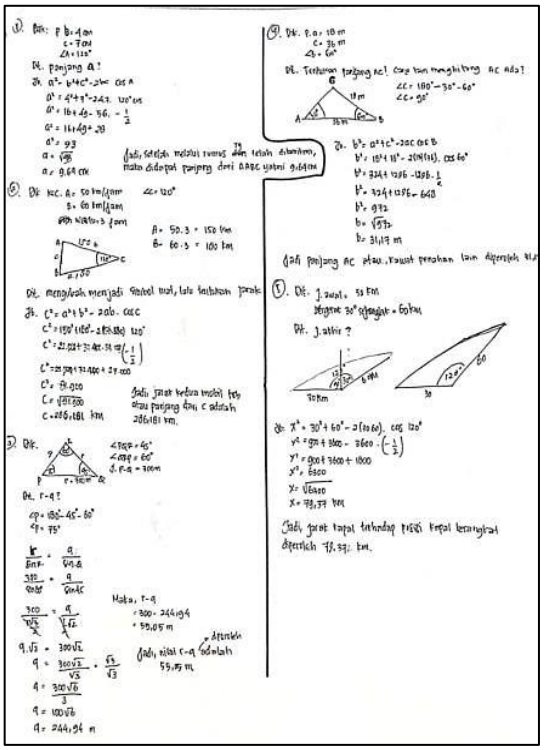

Figure 6. Eksperiment Class Posttest Results.

Figure 6 shows that in the first problem, students wrote the known and asked information on their answer sheet. As many as 94,45% of students in the high category who can answer the first question by writing the known and asked completely. This is in accordance with research (Septikayanti et al., 2022) where students who have high abilities can write known and questioned information and are able to write ideas or solutions when solving problem problems correctly and completely.

In the second problem, students were able to express mathematical ideas in writing well. As many as 91,67% of students in the high category who can answer the second question using mathematical symbols or terms. This is in accordance with research (Septikayanti et al., 2022), where high category students are able to master the writing aspect well and are categorized as good. And able to use mathematical symbols in writing mathematical situations or ideas.

In the third question, students were able to explain everyday ideas and situations and in writing with pictures well. As many as 86,12% of students in the high category who can answer questions by writing their mathematical ideas in the form of pictures. This is in accordance with research (Ulymaz *et al.*, 2022) that students with high communication abillity will be able to describe mathematical situations or ideas in the form of images well and understand the meaning of presentation in everyday language well and in accordance with the wishes of the problem.

In the fourth question, students were able to understand and evaluate mathematical ideas in solving everyday problems well in writing. As many as 75% of students in the high category who can answer questions by solving problems/questions completely and correctly. This is in accordance with research (Wulandari & Astutiningtyas, 2020) that students with high communication ability will be able to represent mathematical concepts and solutions appropriately and relevant to the problems given. In the fifth problem, students are able to provide the final conclusion in solving the problem. A total of 77,78% of students in the high category who can answer questions by writing conclusions at the end of the solution.

After analyzing the results of students' answers in the experimental class and the control class, it is clear that the Two Stay Two Stray learning model has an effect on students' mathematical communication ability. In the control class, most students have not been able to meet the desired indicators of mathematical communication ability. This is in line with research (Une et al., 2023) that the Two Stay Two Stray learning model provides opportunities for students to work together and communicate and are able to present sentences into mathematical models and provide learning experiences that have never been done before by students.

Overall, throughout the learning process, the mathematical communication ability that showed a significant increase were in the experimental class students who used the Two Stay Two Stray learning model. Students showed activeness in communicating in their respective discussion groups. They actively discussed

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with the group, responded to friends' answers, and expressed their opinions. Thus, the mathematical communication ability of students have increased.

IV. CONCLUSION

The conclusion of this study is that the average mathematical communication ability of students taught using the Two Stay Two Stray learning model is higher than the average mathematical communication ability of students using the Direct Interaction learning model. This is evidenced by the significance value which shows a significance value of 0,000, where the value is smaller than the significance level of 0,05 (0,000 < 0,05). Thus, the alternative hypothesis (H_a) is accepted and the null hypothesis (H_0) is rejected. The effect size is 1,7 which is included in the high category. This indicates that the d of the Two Stay Two Stray learning model has an effect of 95,5% on students' mathematical communication ability of class XI students of MAN 1 Medan.

By using the TSTS model, student activities become more lively and positive, which improves the mathematics learning process. This is proven by each meeting showing significant improvement and making students more active. Researchers recommend that further thorough preparation such as mastery of teaching materials, the development of an engaging learning process that can arouse students' curiosity, and careful scheduling are necessary for teachers implementing the TSTS model to ensure an effective and on-plan learning process.

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