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The Improvement of Mathematical Communication Ability and Students' Attitude Through Student Team Heroic Leadership Teaching-Learning Model

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Abstrak

Kemampuan komunikasi matematika sangat penting bagi siswa untuk memecahkan masalah matematika secara efektif. Namun, bukti empiris menunjukkan bahwa kompetensi ini masih kurang berkembang di banyak sekolah di Indonesia, sehingga memerlukan intervensi pembelajaran yang inovatif. Studi ini meneliti efektivitas dua model pembelajaran kooperatif—Kepemimpinan Tim Siswa Heroik dengan diskusi panel (STHL-A) dan Kepemimpinan Tim Siswa Heroik dengan jendela belanja (STHL-B)—dibandingkan dengan pembelajaran konvensional dalam meningkatkan keterampilan komunikasi matematika siswa. Dilakukan di SMP Negeri 2 Selaawi, Garut, Jawa Barat, penelitian ini menggunakan desain kelompok kontrol non-ekuivalen dengan pengambilan sampel bertujuan. Data dikumpulkan melalui pretest, posttest, dan kuesioner sikap skala Likert. Temuan menunjukkan tiga hasil utama. Pertama, tidak ada perbedaan signifikan yang diamati dalam peningkatan kemampuan komunikasi matematika antara kelompok STHL-A, STHL-B, dan konvensional. Kedua, perbedaan signifikan ditemukan dalam pencapaian akhir kemampuan komunikasi matematika, dengan kedua model STHL menunjukkan kinerja yang lebih baik daripada pendekatan konvensional. Ketiga, siswa menunjukkan sikap positif terhadap model STHL-A dan STHL-B. Hasil ini menunjukkan bahwa meskipun ketiga model tersebut menghasilkan peningkatan keterampilan yang sebanding, model STHL lebih efektif dalam mencapai tingkat kompetensi akhir yang lebih tinggi. Selain itu, tanggapan positif siswa menunjukkan bahwa model STHL efektif secara instruksional dan diterima dengan baik. Oleh karena itu, baik STHL-A maupun STHL-B direkomendasikan sebagai alternatif yang layak untuk pengajaran konvensional dalam mendorong komunikasi matematika di lingkungan sekolah menengah pertama.

Kata kunci: *Komunikasi Matematika, STHL-A, STHL-B*

Abstract

Mathematical communication ability is essential for students to solve mathematical problems effectively. However, empirical evidence suggests this competency remains underdeveloped in many Indonesian schools, necessitating innovative instructional interventions. This study examines the effectiveness of two cooperative learning models—Student Team Heroic Leadership with panel discussion (STHL-A) and Student Team Heroic Leadership with shopping windows (STHL-B)—compared to conventional instruction in enhancing students' mathematical communication skills. Conducted at SMP Negeri 2 Selaawi, Garut, West Java, the research employed a non-equivalent control group design with purposive sampling. Data were collected through pretests, posttests, and Likert-scale attitude questionnaires. The findings reveal three key outcomes. First, no significant difference was observed in the improvement of mathematical communication ability among the STHL-A, STHL-B, and conventional groups. Second, a significant difference was found in the final achievement of mathematical communication ability, with both STHL models outperforming the conventional approach. Third, students exhibited positive attitudes toward both STHL-A and STHL-B models. These results suggest that while all three models produced comparable gains in skill improvement, the STHL models were more effective in achieving higher final competency levels. Moreover, the positive student responses indicate that the STHL models are instructionally effective and well-received. Therefore, both STHL-A and STHL-B are recommended as viable alternatives to conventional teaching for fostering mathematical communication in junior high school settings.

Keywords: Mathematical Communication, STHL- A, STHL-B

1. INTRODUCTION

Indonesian students' low achievement in the *Trends International Mathematics and Science Study (TIMSS)* is due to Indonesian students being poorly trained in arguing (communicating) the idea, reasoning when solving mathematics problems. Communication ability is one of the mathematical thinking skills that must be mastered by students. As the recommendation of the National Council of Teachers of Mathematics *(NCTM,* 2000) suggests, the thought process that includes problem solving, reasoning, communication, connection, and representation must be taught to the students through a lesson.

Several indicators of mathematical communication can be used as a reference in assessing students mathematical communication (Greenes and Schulman,1996), including:1)express mathematical ideas through speech, writing, demonstrations, and describe it visually in a different type, 2)understand, interpret, and assess the ideas presented in writing, orally, or in visual form and 3)Construct, interpret and connect various representations of ideas and its relationship

Based on the pre-studies conducted by researchers at SMPN 2 Selaawi, Garut, in West Java, Indonesia, found that students' mathematical communication ability is still low. This is evident from the results of the mathematics test. Almost all students are not able to connect images and diagrams with mathematical ideas; state daily occurrences in the language or mathematical symbols; and explain ideas, situations, and relationships mathematically orally and in writing with pictures, graphs, and algebra.

Looking at these conditions, it is necessary to conduct a study that provides an opportunity for students to communicate mathematical ideas. Baroody (1993: 107) argues that mathematical ideas can be communicated to students through five aspects, namely representing, communication, listening, reading, discussing, and writing. He also said there are two important reasons why communication in mathematics learning should be the focus of attention, namely: 1) mathematics as languaged and 2) mathematics learning as a social activity. Mathematics as language, meaning that mathematics is not just a tool of thinking (a tool to aid thinking), tools to find patterns, resolve problems, or draw conclusions, but mathematics is also a valuable tool to communicate ideas in a clear, precise, and meticulous. Mathematics learning is a social activity, that is to say as a social activity in learning. Moreover, mathematics is a means of interaction between students and the communication between teachers and students.

The good teaching-learning interactions is the teacher as the teacher does not dominate the learning activities as well as the good student who has the character of a vibrant and good leadership for himself or for another person. Teaching-learning model-based mathematics learning as a social activity and leadership character building for students in order to improve the mathematical communication ability is the Heroic Leadership Student Team (STHL). STHL teaching-learning model is part of cooperative learning (small group learning). Some opinions about cooperative learning are proposed by Slavin (1995) that the working group make students eager to learn actively, present themselves, or play a role among their peers. Cooperative learning can improve social relations and improve student learning outcomes Arends, (2000). The Student Team Heroic Leadership learning (STHL) model is a strategy learning that allows students to think, answer, motivate, help each other, foster an attitude of responsibility towards oneself and others, and can form a heroic leadership spirit.

In the discussion, there will be interaction between the students, which could be a potential for developing the mathematical communication of students. Lundgren (1994) argues that cooperative learning has a very positive impact on the study results of low-ability students. While understanding the heroic leadership, according to Lowney (Sukestiyarni, 2006: 9), explained that the heroic leadership style is the style of leadership that is conscious, like a hero. STHL can be done by two methods: STHL with a *panel discussion* and STHL with *window shopping*. Basically, both models are almost the same, as the set of discussion techniques is implemented. Figure 1. shows the steps of both models.

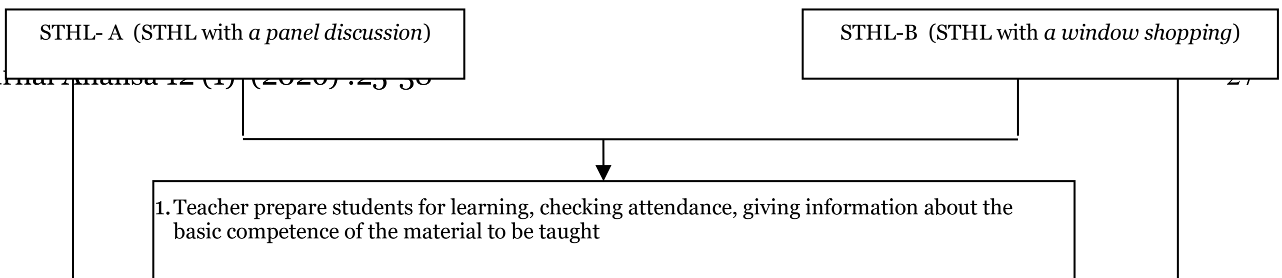

Figure 1. The Steps of the STHL-A and STHL-B Teaching-Learning Model

Implementation of an innovative learning model that will have an impact on students' attitudes. Attitude is a readiness to react to an object in a certain way. Students' attitudes toward the learning model STHL is the degree of positive and negative feelings shown by confidence based on knowledge about the application of STHL through the step-by-step activity. The framework in this study are described as follows:

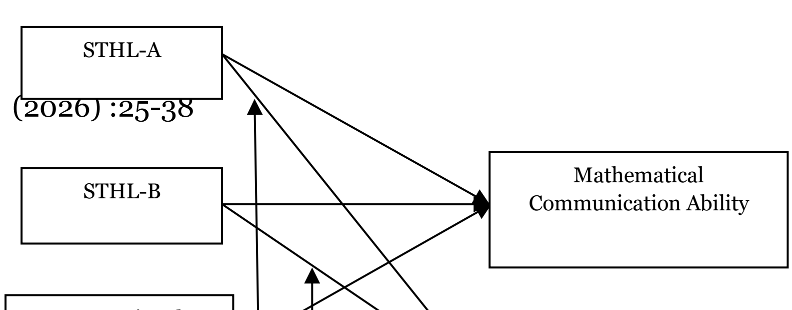

Figure 2. Framework

2. RESEARCH METHODS

The method used in this study is a quasi-experimental research design that approaches a real trial where it is impossible to hold control or manipulate all relevant variables. The variables in the research are the mathematics teaching-learning using the STHL-A, STHL-B, and conventional teaching-learning models as independent variables, and the students' mathematical communication ability as the dependent variable.

The research design used in this study is a non-equivalent control group design. In this design, the initial tests (pretest) and final test (posttest). Pretest was implemented in order to see the beginning of the mathematical communication abilities of students before getting treatment, while the posttest was implemented to see the students' mathematical communication abilities after receiving treatment. The design of the study can be seen as follows:

Table 1. Research design

Pretest	**Treatment**	**Postest**
O	X_1	O
O	X_2	O
O		O

Information:

X_1 = treatment using model of STHL-A

X_2 = treatment using the model of STHL-B

O = problem item of pretest and posttest (mathematical communication test)

Analysis techniques to see differences in the improvement of students' mathematical communication ability used the N-gain formula:

$$\text{N-gain} = \frac{S_{postest} - S_{pretest}}{S_{Ideal} - S_{postest}} \quad \text{(Hake, 1999)}$$

Table 2. Category of NGain

NGain coefficient	Category
g > 0,7	High
0,3 ≤ g ≤ 0,7	Moderate
g < 0,3	Low

Analysis techniques to see differences in achievement students 'mathematical communication ability used one-way ANOVA, and analysis of students' attitudes toward STHL-A, STHL-B teaching-learning model using the calculation of scores of Likert attitude scale

3. RESULT AND DISCUSSION

A. Research Result

The difference of improvement students mathematical communications ability before and after applied model of STHL-A, STHL-B and conventional

At the first meeting in each class are given a pretest in order to determine the ability initial of students mathematical communication. The following figure of the average pretest students in the third grade (the STHL-A, STHL- B, and Conventional teaching-learning model)

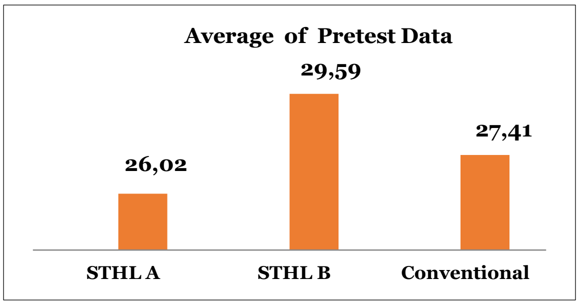

Figure 3. Data on average pretest

Below is a table of data pretest descriptive statistics of each model of learning

Table 3. Descriptive Statistics Data Pretest

	N	Mean	Std. Deviation	Minimum	Maximum
STHL -A	36	26,02	4,389	18,33	36,67
STHL -B	37	29,59	6,142	16,67	41,67
Conventional	36	27,42	5,015	18,33	41,67
Total	109	27,69	5,400	16,67	41,67

Ideal Score = 100

The pretest results showed that students' initial mathematical communication ability in the three classes were relatively low. The average scores of STHL-A, STHL-B, and the conventional class were 26.02, 29.59, and 27.42, respectively, out of an ideal score of 100. These results indicate that students still experience difficulties in expressing mathematical ideas, interpreting visual representations, and connecting mathematical symbols to everyday situations. Therefore the three groups had comparable initial abilities and required treatment in the form of implementing learning models to improve their mathematical communication ability.

Having obtained the data postest further research carried out by applying the learning of the STHL-A, STHL-B and Conventional teaching-learning model. Then the students were given a posttest. The average score of posttest of each class can be seen from Figure 4.

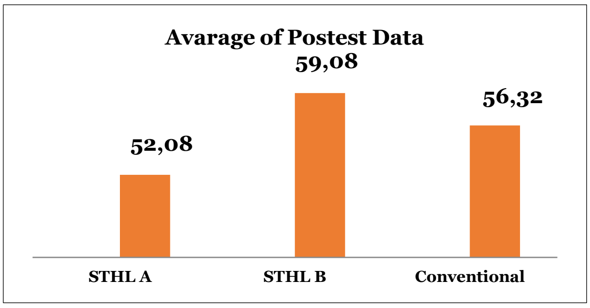

Figure 4. Data on average postest

The posttest results showed an increase in the average score in all classes after the learning process. Class STHL-B obtained the highest average score (59.08), followed by the conventional class (56.32) and class STHL-A (52.08). This finding indicates that STHL-B through the window-shopping technique is superior compared to STHL-A (panel discussion technique) and conventional, this is because STHL-B provides more opportunities for students to present, compare, and discuss mathematical ideas with peers. These activities support students in constructing their mathematical explanations more clearly and confidently. Below is a table of data pretest descriptive statistics of each model of learning.

Table 4. Descriptive Statistics Data Postest

	N	Mean	Std. Deviation	Minimum	Maximum
STHL -A	36	52,08	7,281	35,00	68,33
STHL -B	37	59,08	10,056	40,00	78,33
Conventional	36	56,32	7,559	46,67	73,33
Total	109	55,86	8,8201	35,00	78,33

Ideal Score = 100

From Table 4 shows that the students postest average in the STHL B model more than high if compare with the students postest average in the STHL-A and conventional teaching-learning model. Furthermore, to see the differences in improvement of student mathematical communication ability between before and after applying the STHL-A, STHL-B, and conventional teaching-learning model will be tested on the average N-Gain of each class. The following table average N-Gain in each class

Table 5. Average N Gain in each class

Teaching-learning model	Average	Criteria
STHL- A	0,59	moderate
STHL- B	0,73	moderate
Conventional	0,73	moderate

But before going on the assumption that the normality of data from the third gain index data model of teaching-learning. Based on the analysis of data normality result that, the data are not normally distributed, so to examine differences in the improvement of third grade using non-parametric tests, namely Kruskal-Wallis (H test). Results are as follows

Table 6. Analysis of Kruskal Wallis Gain Index Data

	Indeks Gain
Chi-Square	1,804
df	2
Asymp. Sig.	0,406

Table 6 shows that the significant value is 0,406, so the value of Sig. > 0.05, meaning that there is no difference in improvement of students' mathematical communication ability before and after use of the STHL-A, STHL-B, and Conventional teaching-learning model.

The Kruskal-Wallis test results indicate that the differences in students' mathematical communication skills improvement between the three classes were not statistically significant. The impact on mathematics learning is that all three learning models were able to produce improvements, but the magnitude of the improvements was relatively similar. These results also indicate that the implementation of STHL requires stronger classroom conditioning, particularly in building active group leadership, peer motivation, and equal participation among group members. Without these elements, the potential benefits of the heroic leadership component may not be fully reflected in the N-gain comparison.

The difference in achievement of the students' mathematical communications ability after applying the STHL-A, STHL-B, and the Conventional teaching-learning model

To determine differences in achievement between students who learn with the STHL-A, STHL-B, and the Conventional teaching-learning model, one-way ANOVA will be used. But before going to test assumptions that must be met. Such assumptions are the data should be normally distributed and that the variance should be homogeneous.

Based on the test results of the assumptions, the obtained results indicate that the post-test data were normally distributed and the variances were homogeneous. So as to determine the differences achievement of students mathematical communication ability of the third teaching-learning model used one-way ANOVA test. Summary of test results of the posttest data is shown in Table 7.

Table 7. Result of Postest Data One- way ANOVA

Table	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	432,181	2	216,09	3,374	.038
Within Groups	6789,531	106	64,052		
Total	7221,712	108			

From Table 7 obtained significant value is 0,038 so the value of Sig. > 0, 05, its the meaning that there are differences achievement between students' mathematical communication abilities who learning with the STHL-A, STHL-B, and Conventional teaching-learning model. Furthermore, to see the respective differences achievement of students mathematical communication ability in the each teaching-learning model to do a further test, namely Post Hoc Tests - LSD, the results can be seen in Table 8. Table 7 shows a significance value of 0,038, indicating a Sig. <0,05. This indicates a difference between students' mathematical communication skills after learning with the STHL-A, STHL-B, and conventional learning models. Furthermore, to identify differences in students' mathematical communication skills across learning models, a post-hoc LSD test was conducted. The results are shown in Table 8.

Table 8. Multiple Comparasions

Post Hoc Tests-LSD

(I) Teaching_Learning _Model	(J) Teaching_Learning_ Model	Mean Difference (I-J)	Sig.
STHL- A	STHL- B	-7,00021*	.001
	Conventional	-4,24222*	.035
STHL- B	STHL -A	7,00021*	.001
	Conventional	2,75799	.164
Conventional	STHL -A	4,24222*	.035
	STHL -B	-2,75799	.164

*. The mean difference is significant at the 0.05 level.

The ANOVA results indicate that the type of learning model influences students' mathematical communication skills. Although improvement scores did not differ significantly, post-test results differed across classes. This suggests that students' final performance is influenced by the learning experience, particularly how the model facilitates discussions, presentations, and peer interaction during the mathematical problem-solving process.

STHL-A versus STHL-B
From Table 8, it can be seen that the STHL-A and the STHL-B teaching-learning models have an average difference of 7,00021. For the significant value of the LSD, a value of significance of 0.001. This significance value is 0.001 < 0.05. It means that there are differences in the achievement of the student's mathematical communication ability between student use the STHL-A teaching-learning model with student use the STHL-B teaching- learning model

These results indicate that the STHL-B model produces significantly higher achievement than the STHL-A model. The window-shopping activity in STHL-B allows students to move between groups, observe other groups' solutions, ask questions, and revise their own mathematical explanations. This interaction creates a richer communication environment than the panel discussion format used in STHL-A.

STHL-A versus Conventional
From Table 8, it can be seen that the STHL-A and conventional teaching-learning model have an average difference of 4,24222. For the significant value of the LSD, a value of significance of 0.035. This significance value is 0.035 and 0.05. It means that there are differences in the achievement of the student's mathematical communication ability between student use the STHL-A teaching-learning model with student use the conventional teaching-learning model.

These results show that the differences between the STHL-A and the conventional model indicate that the panel discussion format has different effects on student achievement; however, the lower mean scores of the STHL-A indicate that panel discussions require stronger preparation, a more structured role, and more active leadership from the group leader so that all students can participate in explaining mathematical ideas.

STHL-B versus Conventional
From Table 8, it can be seen that the STHL-B and conventional learning models have an average difference of 2.75799, and the LSD test significance value is 0.164. This significance value is greater than 0.05, which means there is no significant difference in the achievement of students' mathematical communication skills between students who learn using the STHL-B learning model and students who learn using the conventional learning model. To determine the best order of the three learning models, the average posttest score can be seen in Figure 5. The insignificant difference between STHL-B and the conventional model indicates that STHL-B has not produced statistically stronger achievements than conventional learning. However, the higher average score of STHL-B indicates a positive practical tendency. The window shopping activity in STHL-B encourages students to be more active, collaborative, and responsible in communicating mathematical ideas, although the difference is not statistically significant.

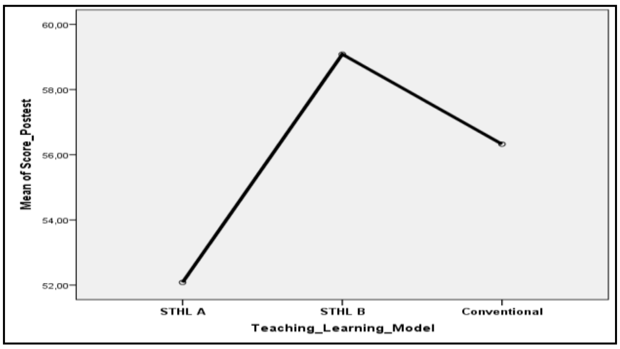

Figure 5. Postest Mean Plot of the STHL-A, STHL- B and Conventional Teaching-Learning Model

If sorted, the students postest average in the STHL-B teaching-learning model are superior to the students postest average in the STHL-A and conventional teaching-learning model

Students' Attitude toward the STHL-A and STHL-B Teaching- Learning Model

For more details, students' attitude toward the STHL-A and STHL-B teaching-learning model can be seen in Table 9 and Table 10.

Table 9. Students' Attitude Toward The STHL-A Teaching-Learning Model

Aspec	Indicator	Netral Students' attitude average	Students' attitude average
Students' attitude toward the STHL-A teaching-learning model	a) Students' attitudes towards the division of the group	2,50	3,14
	b) Students' attitudes towards to election of the chairman of the group that heroic		2,85
	c) Students' attitudes towards the provision of motivation of the group leader		3,24
	d) Students' attitudes towards the presentation held		3,08
	e) Students' attitudes towards closing activities		3,21

Based on Table 9 shows that the average score of the students' attitudes in every aspect is more neutral score, its the meaning that students show positive attitudes toward the STHL-A teaching-learning model. Students' attitude toward the STHL-B teaching-learning model can be seen in Table 10

Table 10. Students' Attitude Toward The STHL-B Teaching-Learning Model

Aspec	Indicator	Neutral Students' attitude average	Students' attitude average
Students' attitude toward the STHL-B teaching-learning model	a) Students' attitudes towards the division of the group	2,50	3,12
	b) Students' attitudes towards the election of the chairman of the group that is heroic		2,98
	c) Students' attitudes towards the motivation of the group leader		3,21
	d) Students' attitudes towards the presentation held		3,24
	e) Students' attitudes towards closing activities		3,15

Based on Table 10 shows that the average score of the students' attitude in every aspect is more neutral, its the meaning that students show positive attitudes toward the STHL-B teaching-learning model.

Attitude data also supported the quantitative findings. Students responded positively to group assignments, heroic group leadership, motivation from group leaders, presentation activities, and closing activities, indicating that the STHL model was enjoyable for them. Positive attitudes toward presentation activities indicated that students felt more engaged when given the opportunity to explain and exchange mathematical ideas with peers.

These findings were also supported by an N-gain analysis, which revealed no significant differences in the improvement of students' mathematical communication skills among the STHL-A, STHL-B, and conventional learning models. The N-gain indices were 0.59, 0.73, and 0.73, respectively. STHL-A scores were in the moderate category, while STHL-B and conventional scores were in the high category.

Based on the findings during the teaching-learning process in the three-teaching-learning model, students are less active in solving mathematical problems of communication. Among group members, do so. Supposedly, the head of the group who have been to have heroic leadership style, like a hero, according to Lowney (2005), who explains that the heroic leadership style is the style of leadership that is conscious, like a hero, and self-awareness to develop the potential by increasing personal skills continuously. But when the researchers in the field is very difficult to find students who have properties that can be heroic in inviting friends to participate actively in group discussions, this has an impact on the group's activities and student learning outcomes. This is also supported by the results of research by Saputra, et al (2014), which states that the average increase in the mathematical communication skills of students who use the STHL type cooperative learning model is higher than that of students who use conventional learning. The results of other research conducted by Anggel (2019) on the Student Team Heroic Leadership learning model on Mathematical Communication Skills were that the increase in mathematical communication skills of students who received the Student Team Heroic Leadership (STHL) learning model was higher than that of students who received the conventional learning model.

Differences of student mathematical communication achievement after receiving treatment the STHL-A, STHL-B and conventional teaching-learning model is not too significant. Of the three teaching-learning models, student mathematical communication achievement is highest in model of the STHL-B, then conventional and STHL-A teaching-learning model. In the STHL-B teaching-learning model, students are more enthusiastic because this learning requires them to be active and they are learning that different from that normally carried out especially when presenting the results of discussions by way of exchange visits with other groups. This is because the methods of cooperative learning type of window shopping (shopping works) will bring students do not just understand the material/mathematical concept, but also deliver them to the planting of the character of cooperation, courage, democratic, curiosity, the interaction between friends, and responsible (USAID, 2013). Window shopping activity is very attractive to students, because the students do not only see the results other groups but also noted the results of such work to share with group members. In addition to group work activities are peer tutors.

Furthermore, based on the analysis of students' attitudes toward the STHL-A and STHL-B teaching-learning model showed the students positive attitudes. Students learn different feel than usual, their presentations while itinerant work was a new experience for students. Attitude is one's feelings about the objects, activities, events, and others. This feeling is a concept that represents the likes or dislikes (positive, negative, or neutral) someone on something. In this case the student represents positive feelings toward the STHL-A and STHL-B teaching-learning model indicated by confidence based on knowledge about how to follow the learning path.

This finding addresses the gap identified in the introduction, namely students' low ability to communicate mathematical ideas, connect diagrams with mathematical expressions and explain mathematical situations orally and in writing. The implementation of STHL especially STHL-B through window shopping, provides a learning environment that can train students to express ideas, listen to peer explanations, ask questions, and compare different representations. Thus, this study provides evidence that integrated cooperative learning with heroic leadership and peer presentation activities can be used as an alternative strategy to address students' weak mathematical communication skills and to build a more positive attitude towards mathematics learning.

4. CONCLUSION

Based on the analysis, it was concluded that improving students 'mathematical communication ability in the STHL-A class is no different from improving students' mathematical communication ability in the STHL-B class and in the Conventional class. However, when viewed in each class of students' mathematical communication ability experienced a significant improvement, that is, in the STHL-A class the n-gain index is 0.59, including the moderate category, in the STHL-B class, and the Conventional class of n-gain index is 0,73 are in the high category.

Furthermore, the achievement of students' mathematical communication ability in STHL-A, STHL-B, and the Conventional teaching-learning model differs significantly; the achievement of students' mathematical communication ability in the STHL-A teaching-learning model was different from that of the students in the STHL-B teaching-learning model, as well as the achievement of students' STHL-A teaching-learning model is different from that of the students in the Conventional class, but the achievement of students' mathematical communication ability in the STHL-B class is no different from that of the Conventional teaching-learning model. If sorted by the average achievement of students' mathematical communication ability in the STHL-B teaching-learning model are superior (first order) then students in the second-class Conventional teaching-learning model and students in the STHL-A teaching-learning model are third.

Students demonstrate a positive attitude towards the STHL-A and STHL-B teaching-learning model. This is because both models are a model of learning that demands a peer tutor. By choosing a group leader who has a heroism, panel discussions, and window shopping provide new experiences for students in learning mathematics

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