

## **The Influence of the STEAM Learning Model on Mathematics Learning Outcomes in Percent Material**

**Annisa Khairah\***

Madrasah Ibtidaiyah Teacher Education, UIN North Sumatra, North Sumatra, Indonesia

**Sapri Sapri**

Madrasah Ibtidaiyah Teacher Education, UIN North Sumatra, North Sumatra, Indonesia

**Lailatun Nur Kamalia Siregar**

Madrasah Ibtidaiyah Teacher Education, UIN North Sumatra, North Sumatra, Indonesia

\*Correspondence author: [khairahannisa@gmail.com](mailto:khairahannisa@gmail.com)

### **Abstract:**

The aim of this research is to determine the effect of the STEAM (Science, Technology, Engineering, Art and Mathematics) learning model on mathematics learning outcomes in percent material in class IV SDIT Al-Fauzi, Medan City. This research uses quantitative field research methods and uses a pre-test and post-test control group design. 22 students from class IV-A were used as the control class and 22 students from class IV-B were used as the experimental class. Multiple choice test instruments are used to determine students' level of knowledge. The t-test is used to analyze research hypothesis data. The one-way anova test is used to analysis homogeneity data. By using one-way analysis of variance with a significance level of 0.05, the sig value is 0.000, which means 0.000 is less than 0.05. This situation shows that the STEAM learning model has a significant impact. In the experimental class, students obtained an average learning result of 81.45 with a difference in pre-test and post-test scores of 52.04. Meanwhile in the control class, students obtained an average learning outcome of 67.90. Therefore, the application of the STEAM model has a significant impact on the learning outcomes of students at SDIT Al-Fauzi Medan City in mathematics learning.

### **Keywords:**

Mathematics; STEAM Model; Student Learning Outcomes

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## Introduction

Education is an effort to prepare student activities carried out by educators so that they effectively help develop individual potential, abilities and true talents. Students' process skills and social skills must be improved in the world of education through learning activities. Because, the quality of human resources is influenced by education and the learning process (Nasrah et al., 2021:2).

Every educator in the era of industrial revolution 4.0 has challenges in building knowledgeable individual character, increasing human resources and achieving national development goals, especially improving the welfare of society. For this reason, the ability to understand conceptual knowledge is not enough for students, but the ability to think creatively in dealing with problems is needed (Anderha & Maskar, 2021:2).

Currently, the academic world in Indonesia is in the 21st century, where there is a wave of globalization. However, the quality of formal and non-formal education in Indonesia is lagging behind, when compared with other countries. Currently, the quality of formal and non-formal education is lagging behind. This was obtained after comparing with various countries. Indonesia was ranked seventh in ASEAN in 2017 with a score of 0.622 based on the Educational Index issued by Human Development Reports. Singapore scored the highest at 0.832. Malaysia is in second place with a score of 0.719. Next, Brunei Darussalan with a score of 0.704 (Nurhasanah & MS, 2021:206). Therefore, the low quality of education is a big effort for educators to continue to compete to provide the best education so that they can compete with various countries.

In Indonesia, the low quality of education is caused by the low quality of educators and low student achievement. The very worrying condition of the teaching staff in Indonesia also results in the low quality of education, because teachers' skills are insufficient to carry out their duties. According to Article 39 of Law no. 20/2003 teacher skills include leadership, learning planning, organizing training, implementing learning, evaluating learning outcomes, conducting research and providing community service (Agustang et al., 2021:7).

Creative and fun learning should be used in elementary school learning. However, students spend their study time in elementary school (SD) reading, writing, arithmetic (calistung) instead of studying and investigating, exercising/practicing, and imagination. Therefore, all student development should be supported by the school children's learning environment.

Most elementary school teachers experience problems in mathematics learning activities. This occurs because of the absence of facilities and infrastructure, media, and innovative learning models applied by educators in capturing numerical ideas. As a result, learning mathematics becomes something difficult and boring for students (Pradana, 2021:2).

When conducting initial observations in class IV at SDIT Al-Fauzi, Medan City, researchers found that learning activities occurred with passive students, while teachers were less creative in implementing learning models in their learning activities. Situations like this make students bored and have low learning outcomes. Mathematics learning results IV-A and IV-B SDIT Al-Fauzi Medan City in the odd semester of the 2022/2023 academic year only reached 58.86 out of 44 students. Meanwhile, the KKM (Minimum Completeness Criteria) for mathematics is 70. Apart from that, another visible phenomenon is that teachers still lack understanding about improving learning outcomes with the STEAM learning model.

The researcher conducted an interview at the end of the lesson with a mathematics teacher at SDIT Al-Fauzi on December, 12 2022 in class IV-A that the learning process was generally teacher-centred, so there was a lack of activity among the students themselves, as a result the students felt boredom and learning outcomes

tend to be low. It does not stop there, student learning outcomes are also low because mathematics class hours are during the day, to be precise from 13.30 to 15.00 and 09.15 to 11.00. This adds to the feeling of boredom and stiffness in learning for students.

Based on observations, mathematics learning takes place conventionally by applying the lecture method, namely the teacher explains the learning material while the student's pay attention and listen to the teacher's explanation. However, there are still students who ignore the teacher, do not actively ask questions, or give their opinions on the material. Apart from that, it was found that students were busy talking with their friends and students were sleepy. This also shows the lack of interest of students in the learning delivered by the teacher.

Based on the findings above, the mathematics learning outcomes of SDIT Al-Fauzi students tend to be low. If this problem is not immediately resolved, students will experience the impact. Students' understanding of mathematics will be weak and have a negative impact on the quality of mathematics education at the elementary school level. Therefore, educational reform needs to be implemented so that the quality of education in Indonesia develops, namely changing the conventional learning process to further improve thinking abilities.

Thus, the learning process offered by the STEAM learning model can help educators transform education and produce high-quality human resources. The STEAM learning model combines elements of science, consisting of science, engineering, technology, arts, and mathematics.

The STEAM learning model combines two or more elements of science which are included in the STEAM component. In the academic field, STEAM is a coordinated approach to art, science, technology, engineering and mathematics, combined in one method to encourage inquiry, correspondence and critical thinking in student learning (Nasrah et al., 2021:2). For this reason, the STEAM model can help answer research-based questions, and can help students create new knowledge through the integration of two or more lesson content, especially at the elementary school level where the learning system is themed.

According to research, implementing the STEAM learning model improves students' academic achievement. The results showed an increase with an average pre-test score of 52.33 and an average post-test score of 92.99 (Zulvira & Desyandri, 2022:1273). Furthermore, students' mathematics scores in STEAM are better than mathematics scores in conventional learning models. The experimental group obtained a higher mean score than the control group. This shows that students who use the STEAM learning model have better mathematics learning outcomes and improve their learning outcomes (Nirmalasari et al., 2021:94).

The novelty of the research lies in the expected impact after implementing the STEAM learning model. In previous research, the expected influence was on creative and critical thinking. In this research, the effect on learning outcomes and on learning mathematics material is percent. Another important difference is the setting of the research location and the research subjects carried out at SDIT Al-Fauzi Medan City for grade IV students.

The researcher concluded that the use of the STEAM (Science, Technology, Engineering, Art, and Mathematics) learning model is important for improving students' learning outcomes and learning experiences. This research aims to determine the effect of the STEAM learning model on mathematics learning outcomes in percent material at SDIT Al-Fauzi Kota Medan.

## **Research Method**

Researchers conducted quantitative research using the type of field research. To investigate how the STEAM learning model impacts mathematics learning

outcomes in percent material in class IV SDIT Al-Fauzi, Medan City. This research is using experimental method. By using a control group design, the researcher conducted research with two samples: a control group and an experimental group, each given pre-test and post-test treatment. In general, the true experimental pre-test and post-test control group design research design is explained as follows.

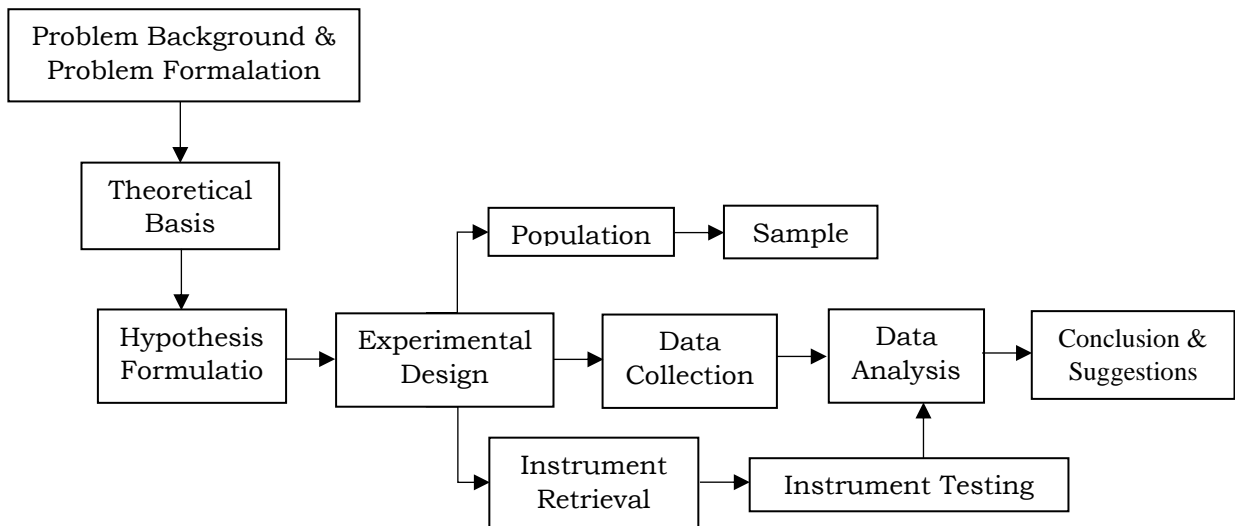
**Table 1. True Experimental Pre-test and Post-test Control Group Design**

Group	Pre-test	Treatment	Post-test
Experiment	O <sub>1</sub>	X <sub>1</sub>	O <sub>2</sub>
Control	O <sub>3</sub>	X <sub>2</sub>	O <sub>4</sub>

Description:

- O<sub>1</sub> = Experimental group given a pre-test
- O<sub>2</sub> = Experimental group given the post-test
- X<sub>1</sub> = Treatment in the experimental group with the STEAM model
- X<sub>2</sub> = Treatment in the control group without the STEAM model
- O<sub>3</sub> = Control group given the pre-test
- O<sub>4</sub> = Control group given the pre-test

The table above provides an overview of the field study design. Two groups were pre-tested to find out whether the initial conditions of the experimental group and the control group were different. The pre-test results are said to be good if there is no significant difference in scores between the two groups. Then the researcher carried out a post-test, the results of which were compared with the pre-test to find out whether the pre-test and post-test scores were different, and to determine whether the control group and experimental group were different. The following image shows the research process.



**Figure 1. Steps for Quantitative Experimental Research**

The image above shows how experimental quantitative research is carried out. This begins by posing a problem, which contains the context of the problem and its formulation. Next, the problem is discussed theoretically and solved. A hypothesis is a theory used to determine how someone can solve a problem and find answers to the problem formulation. This hypothesis is confirmed by certain designs. That's why researchers define certain populations. Researchers use samples as a source of research data because the population studied is large.

This research has a population of 180 students at SDIT Al-Fauzi Medan City for the 2022/2023 academic year. For this reason, the research sample was all fourth grade students at SDIT Al-Fauzi, Medan City, who were taken using a purposive sampling technique. Samples distributed to treatment recipients are shown in table 2 following.

**Table 2. Samples Distribution of Treatment Recipients**

Class	Total Students	
	M	F
IV-A (Control Class)	10 people	12 people
IV-B (Experimental Class)	14 people	8 people
Total	44 people	

Researchers must develop tools to collect data. Before the instrument is used in data collection, researchers test its validity and reliability to ensure the information obtained is valid and reliable. Data from samples are collected. After the data is collected, the data is analyzed. In the next step, conclusions and proposals are made based on data analysis.

Researchers analyze research data once it is available and process it to extract information. The data processed includes the pre-test and post-test results of students in the experimental and control classes. The research material consists of material that measures the impact of the STEAM learning model on mathematics learning. Quantitative data obtained from test results were processed using the IBM SPSS statistics 25 program, consisting of normality test, homogeneity test, average calculation and hypothesis test.

From the data above, it can be seen that 15 questions were tested on 22 students, with an  $r_{table}$  value = 0.432 and a significance level of 0.05. Based on table 4.4, it can be concluded that 15 questions are declared valid because  $r_{count} \geq r_{table}$ .

The questions are tested for reliability after a validity test is carried out so that the consistency of the instrument can be known as a measuring tool. This reliability test uses the Kuder and Richardson technique which consists of 15 questions with a significance level of 5% and degrees of freedom ( $dk$ ) =  $n-2 = 22-2 = 20$  so that the  $r_{table}$  value used is 0.423. The instrument can be declared reliable if  $r_{count} > r_{table}$ .

The calculation results obtained  $r_{table} = 0.423$ . Thus  $r_{count} > r_{table}$  or  $0.844 > 0.423$  states that an instrument is reliable with high criteria.

## Results and Discussion

### Research Data Analysis

#### Descriptive Analysis

Learning outcomes cannot be separated from things that influence learning outcomes as a sign of achieving learning targets. There are two circumstances that influence student learning outcomes, according to Mirdanda (2018:36). The first is the condition within the student or internally. The internal state includes the health and psychology of students. The second is circumstances outside the student or external. External circumstances include the environment and instrumentality of students.

According to Istarani in Ishaac (2020:7) a learning model is a series of material presentations that cover all aspects before, during and after learning. Educators carry out all learning activities based on learning models during the learning process.

During planning activities, models are learning guides that are used to achieve learning goals because of common learning behavior patterns. The learning model combines teaching methods, strategies, learning methods and techniques to carry out learning activities through teacher interaction with students. Thus, the learning

model is described in its entirety through the learning process to be implemented (Octavia, 2020:12).

The STEAM learning model is a multidisciplinary science that starts from STEM learning by adding elements of Art to it. According to (Fahrurrozi et al., 2022:224), STEAM is a learning model that allows students to create technology and science-based ideas to solve problems through thinking and research skills.

According to Tsupros, the STEAM learning model is an interdisciplinary integration of science, technology, engineering, art and mathematics, connecting concepts with the world of work, the global world and school. However, Sanders argues that the STEAM learning model includes teaching various STEAM discipline areas and other school subject matter (Simarmata et al., 2020:11).

Based on the opinion above, the STEAM learning model combines various disciplines, such as art, technology, engineering, science, and mathematics. Because it is important for students to increase their creativity when solving everyday problems.

Currently, STEM education experts combine art with the term STEAM. Creating a project requires the integration of art. Currently, everything from elementary schools to universities in various countries has adopted the use of the STEAM curriculum. Agree with Sanders et al in Sani (2019: 60) who state that all levels of education can carry out STEM integration, because the characteristics of STEAM implementation do not depend on the age of the students but on the intelligence, creativity, and design abilities of the students.

STEAM learning can activate students in their groups so that students are able to achieve cognitive, skill, attitude and creativity targets which are expected to influence learning outcomes. According to Busri in Suprapno et al (2021:10), the steps for STEAM learning are as follows: (1) Starting with important questions; (2) Making a project plan; (3) Prepare a schedule; (4) Track student project progress; (5) Testing and assessing results; and (6) Evaluate experience.

Efforts to improve education can be made by adopting various strategies, including curriculum changes. Indonesian education, especially at the school level, has launched a curriculum. In the 2013 curriculum, mathematics subjects are integrated with other subjects for low classes while being separate subjects for high classes (Widyaningrum, 2022:69).

At SDIT AL-Fauzi Medan City, the experimental class IV-B was chosen as the sample, and the control class IV-A was taught using the discussion method to see how the STEAM model had an impact on the mathematics learning outcomes of the percent of students in class IV.

Data analysis was carried out to facilitate the presentation of data for each research sample. The results of descriptive analysis of data before and after treatment for the control and experimental classes are shown here.

**Table 4. Learning Results in Control and Experiment Classes**

Class	Average Value		Difference in Pre-test and Post-test Scores
	Pre-test	Post-test	
Control	58,272	67,909	9,637
Experiment	29,409	81,455	52,046

Source: SPSS data management

Table 4 shows that the pre-test and post-test scores for the experimental class which received the STEAM model treatment were more effective compared to the control class. The average score obtained after treatment was 81.4, which is quite far above the KKM (Minimum Qualification Criteria) which is 70 compared to the control class.

Inferential Analysis

Normality Test

To determine the normality of the data, a normality test was carried out. In this study, the one sample Kolmogrov-Smirnov normality test was used with a significance level of 0.05 via SPSS Statistics 25. If sig > 0.05 then the data is normally distributed. If sig < 0.05, it means the data is not normally distributed. The learning outcomes of students in the experimental class who were treated with the STEAM model and students in the control class who were treated with the discussion method were used to test the normality of the data. Following are the results of the normality test questions.

**Table 5. Normality Test Results Data**

<b>Data (Learning Results)</b>	<b>Total Students (N)</b>	<b>Sig. Value</b>	<b>Conclusion</b>
Pre-test Experiment	22	0,200	Sig > 0,05 data with normal distribution
Post- test Experiment	22	0,073	
Pre-test Control	22	0,103	
Post-test Control	22	0,144	

Source: SPSS data management

Based on table 5, the significance of the pre-test score on the academic performance of students in the experimental class is 0.200 and the significance of the post-test is 0.073 with a significance level of 0.05. Meanwhile, the significance of the pre-test and post-test scores on the learning outcomes of control class students was 0.103 and 0.144 respectively. Based on these results, the researchers concluded that the data was normally distributed.

Homogeneity Test

The homogeneity test in this study used one-way anova analysis in SPSS statistics 25 with a significance level of 0.05 for the homogeneity of variance test. If sig. > 0.05, then the data is homogeneous and if sig < 0.05 then the data is said to be homogeneous. The homogeneity test results are as follows:

**Table 6. Homogeneity Test Results Data**

<b>Data (Learning Results)</b>	<b>Homogeneity</b>	<b>Significance</b>	<b>Conclusion</b>
Control Class	0,665	0,665 > 0,05	Homogeneous
Experimental Class	0,238	0,238 > 0,05	Homogeneous

Source: SPSS data management

Based on table 6, the control class homogeneity test results are 0.665 > 0.05 and the experimental class homogeneity test results are 0.238 > 0.05, it can be concluded that Ha is accepted. Thus, each sample is taken from the same population.

Hypothesis Test

A significance level of 0.05 is used in the results of one-way calculations (Anova) in the SPSS program using a significance level of 0.05. If the sig value is > 0.05 then the averages are the same, or Ho is rejected, and if the sig value < 0.05 indicates that the averages are different or Ha is accepted. Analysis of variance one as follows:

**Table 7. Hypothesis Test Results**

<b>Hypothesis Test Results</b>	<b>Significance</b>	<b>Test Decision</b>
0,000	0,000 < 0,05	Accepted

Source: SPSS data management

Table 7 shows the hypothesis test results of  $0.000 < 0.05$ , which means that the influence on the learning outcomes of the two groups is different. It can be concluded that  $H_0$  is rejected and  $H_a$  is accepted, which means the treatment has a significant influence on the experimental class.

$H_a$ 's hypothesis or conclusion is accepted, which means that the mathematics learning outcomes of students who use the STEAM learning model ( $\mu_1$ ) and the discussion method ( $\mu_2$ ) are different. The average learning outcome of students in the experimental class that applies the STEAM model is 81.455, while the discussion method learning outcome is 67.909 according to Table 4. The difference between the pre-test and post-test scores for the control class was 9.637, while the experimental class was 52.046. Therefore, learning outcomes in the experimental class have a greater impact than learning outcomes in the control class. Learning outcomes can be influenced by STEAM learning.

### Research Discussion

The aim of the research is to test its effect on learning outcomes. The influence of learning outcomes is known through the application of the STEAM model and discussion methods in mathematics learning at SDIT Al-Fauzi, Medan Amplas District. Researchers took two samples, namely 22 people from class IV-A as a control class (using the discussion method) and 22 people from an experimental class from class IV-B (using the STEAM model). The material in this research is about percent.

### Learning Process in Control Class using Discussion Method

The discussion method is a teaching method that guides students in solving problems. The goal is to solve problems, answer questions, understand information, and help students make decisions.

During the first meeting, the researcher gave pre-test questions to the students to find out how much they understood the material provided. Students obtained an average of 58.272 from the pre-test exam results. Thus, it is concluded that students' basic abilities are low.

During the second meeting, the researcher carried out learning activities using the discussion method, percent material. At this meeting the researcher explained the material based on the RPP that had been previously designed. There are several obstacles that researchers face when applying this method. One of them is that students do not pay attention to the material being explained, which causes many students not to understand the lesson. Apart from that, students also do not try to answer or ask for explanations about the material explained by educators during discussion and question and answer sessions. Students tend to be quiet and look bored so that interaction between students and educators is very lacking.

Next, the researcher gave practice questions in the student's book and asked the students to complete them. Many students were confused and asked questions to educators, this incident proved that students' understanding of the material that had been presented through this discussion method was still low.

In the final stage, students receive a learning assessment carried out by researchers in the form of a post-test so that the influence of mathematics learning after using the discussion method is known. With a difference of 9.637 pre-test and post-test, this control class obtained an average of 67.909.

### Learning Process in Experimental Class with STEAM Model

According to Tsupros in Simarmatha (Simarmata et al., 2020), the STEAM learning model is a learning model that integrates two or more educational fields including science, technology, engineering, artistic and mathematics. This model connects the concept to the world of work, the global world, and school.



By implementing the STEAM model in education, student learning outcomes can be improved. This finding is in line with research by Nirmalasari (2021), which found that students who studied with the STEAM model had better mathematics scores compared to students who studied with the conventional model. The experimental group got better post-test scores than the control group. This means that students who use the STEAM learning model have better learning outcomes in mathematics.

At the first meeting, students are given multiple choice pre-test questions related to preliminary studies by researchers so that students' initial abilities can be determined. It was shown that the students' initial ability for the material to be presented was still low, with a pre-test average of 29.409. Next, the researcher divided the groups that had been determined, so that each group was divided equally and fairly. At this stage, students are asked to first discuss the names of their groups, namely the names of snacks according to the list of snacks that the researcher has prepared.

At the second meeting the researchers applied the STEAM model where all activity plans were contained in the RPP which had been designed in advance. The initial activity started with an ice breaking song with the title "Balonku" where the song lyrics were replaced with the vowel "a" and chants of "pat the spirit". Before implementing the STEAM model stages, the researcher provides an overview of the learning activities that will be carried out, so that students observe the nutritional value information on the snack packaging that has been provided. These observations will be related to mathematics subjects regarding percent and science regarding healthy food.

The next stages follow the steps in the STEAM model, according to Izzani, (2019:11), namely that STEAM learning has five stages in its implementation in the classroom, consisting of; 1) Observation (observe); 2) New ideas (new ideas); 3) Innovation (innovation); 4. Creativity; and 5) Values (society).

In the first step, the researcher presented short material, followed by students observing the nutritional value information on the snack packets that had been provided in each group and working on the LKPD sheets in each group. Then, researchers asked students to write down all activities related to the percent material that they used in their daily activities.

In learning activities, students use snack packaging media to obtain nutritional value information in the form of percentages and try to change the percentage numbers to decimal form. After that, students describe the nutritional value information on food packaging so that it is written on the LKPD sheet.

The activity continued with the students' LKPD results being presented by the students in front of the class regarding information on the nutritional value of their snacks which had been expressed in percent and decimal form. Students apply the ideas they have generated to real social life. Then, researchers linked mathematics learning about percent material with science learning about healthy food (carbohydrates, proteins, fats, minerals, and vitamins).

Learning outcomes are determined at the end of the evaluation. The average learning influence of students in the experimental class was 81.455 and the difference before and after the test was 52.046. The result is that learning outcomes are better by applying the STEAM model. In accordance with the opinion of Arsy & Syamsulrizal (2021), the STEAM method improves cognitive aspects. They also said that to face future challenges, students must be creative.

In fact, at least two or more STEAM fields are involved in the learning process. STEAM learning has various advantages, including being able to prepare the next generation who are ready to face current developments and help develop innovation in life. Another example of implementing STEAM in mathematics learning, for

example learning social arithmetic material such as percent, can be done by making processed food products. Students make posters to market products as well as make discounts and carry out buying and selling transactions with consumers. Through this example, students do not only use cognitive aspects, but skills and affective aspects of students also play a role in dealing with consumers (Nurhikmayati, 2019:48).

STEAM-based learning can also be linked to the need for developing 21st century skills, namely critical thinking, creativity, collaboration and communication skills. In line with this, STEAM-based learning also requires students to identify a problem, create something to solve the problem, collaborate with classmates to solve problems, and communicate effectively and respond to each other's ideas.

Mathematics is a subject that is expected to benefit students in their daily lives. Mathematics is an ideal subject that can develop children's thinking processes from the end of primary education, middle school, high school education and even up to university. It is given so that the student knows the principles of mathematics in everyday life, working on a task, calculating, and solving problems at school or in the community (Marini et al., 2022:68).

Numerous nations, including the United States, Australia, South Korea, Canada, Thailand, and others, are conducting studies on the application of STEAM education components. According to a study of experiences with implementing STEAM education, there are a variety of ways to include the element "ART" into the acronym STEAM, and these opportunities grow as kids advance through the foundational stages of schooling (Shatunova et al., 2019:134).

Students in these educational programs need to acquire a variety of hard and soft skills in order to be able to adjust to the changes that are occurring in their environment. Critical thinking, creativity, cooperation, communication, physical knowledge, logical mathematics, and social skills are among the abilities that must be taught. The learning process needs to incorporate these abilities (Wahyuningsih et al., 2020:34).

Based on research conducted in both classes, it was found that learning with the STEAM model reached the KKM limit. The test results showed that students in the experimental class were better at mathematics than students in the control class. Therefore, it can be concluded that using the STEAM model in mathematics learning can improve students' academic achievement.

## Conclusion

The mathematics results of the control class using the discussion method averaged 67.909 with an average pre-test score of 58.272, and the difference in pre-test and post-test scores averaged 9.637. The mathematics results of the experimental class with the STEAM model averaged 81.455 with a pre-test score of 29.409 and the difference between the pre-test and post-test scores averaged 52.046. The STEAM model influences students' mathematical abilities. An anova test with a result of 0.000 and a sig value of 0.000 < 0.05 shows that the experimental class has different learning outcomes. Students' mathematics learning outcomes are better influenced by the STEAM model than the discussion method, as shown by the increase in learning outcomes in the experimental class compared to the control class.

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