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The Effect of STEM Learning Method on Students' Mathematical Concepts Understanding in Social Arithmetics Topic

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Abstract. *Mathematical concepts understanding is the main foundation for mastery of more complex material so that appropriate learning methods are needed to improve students' understanding of mathematical concepts. This study aims to determine the effect of the Science, Technology, Engineering, and Mathematics (STEM) learning method on the students' mathematical concepts understanding in social arithmetic topic. The research method used in this study was a quasi-experimental design with a nonequivalent pretest-posttest control group design. This research was conducted at a junior high school in Serang, Banten, using a probability sampling technique. The instrument used is a test of the mathematical concepts understanding. The test results of the mathematical concepts understanding were analyzed using the t-test and N-Gain to determine the increase in students' mathematical concepts understanding. The results showed that the STEM learning method had a significant influence on increasing students' mathematical concepts understanding in social arithmetic topic. However, the use of the STEM learning method to improve students' mathematical abilities in general in various mathematical materials still requires further research.*

Keywords: *Mathematical Concepts Understanding; Science, Technology, Engineering, and Mathematics (STEM); Social Arithmatics Topic*

Abstrak. Pemahaman konsep matematika merupakan landasan utama penguasaan materi yang lebih kompleks sehingga diperlukan metode pembelajaran yang tepat untuk meningkatkan pemahaman konsep matematika siswa. Penelitian ini bertujuan untuk mengetahui pengaruh metode pembelajaran *Science, Technology, Engineering, and Mathematics* (STEM) terhadap pemahaman konsep matematis siswa pada topik aritmatika sosial. Metode penelitian yang digunakan dalam penelitian ini adalah quasi eksperimen dengan desain *nonequivalent pretest-posttest control group design*. Penelitian ini dilakukan pada sebuah sekolah menengah pertama di Serang, Banten, dengan menggunakan teknik *probability sampling*. Instrumen yang digunakan adalah tes pemahaman konsep matematika. Hasil tes pemahaman konsep matematis dianalisis menggunakan uji t dan N-Gain untuk mengetahui peningkatan pemahaman konsep matematis siswa. Hasil penelitian menunjukkan bahwa metode pembelajaran STEM mempunyai pengaruh yang signifikan terhadap peningkatan pemahaman konsep matematika siswa pada topik aritmatika sosial. Namun penggunaan metode pembelajaran STEM untuk meningkatkan kemampuan matematika siswa secara umum pada berbagai materi matematika masih memerlukan penelitian lebih lanjut.

Kata kunci: Aritmatika Sosial; Pemahaman Konsep Matematis; *Science, Technology, Engineering, and Mathematics* (STEM)

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INTRODUCTION

In the 21st century, humans are required to master certain skills that help humans survive according to technological developments. These skills are equipped through education that is collaborative, involves relevant daily life contexts, and is student-centered (Mayasari et al., 2016). Therefore, improving the quality of education with a global perspective must be pursued (Suradi, 2018). One of the subjects prepared to train 21st century skills is mathematics.

Mathematics is a compulsory subject in schools with the aim of equipping students with the basics of mathematical knowledge and a set of mathematical thinking methods needed to solve problems. Therefore, mastery of mathematical concepts must be trained continuously. Mastery of a mathematical concept will affect the understanding of other concepts because mathematics consists of various interrelated topics (Laili & Puspasari, 2018). In addition, mathematics also has a relationship with other sciences and is related to the problems of everyday life. Although mathematics is often seen as an isolated science and is perceived as a difficult topic (Siregar, 2017).

The main problems faced by students in learning mathematics are failure to understand basic mathematical concepts and the view that mathematics has no practical benefits. To overcome this problem, concept understanding is the most important thing for students (Kesumawati, 2008). Good or poor concept understanding will affect the next level of education (Novitasari, 2016). Understanding mathematical concepts is the basis for understanding more abstract concepts (Putra et al., 2018).

One of the efforts that can be made by teachers is to improve the quality of mathematics learning so that it is not boring for students (Choiriah, 2019). Students are led to understand mathematics as well as understand its relationship with other sciences such as applied sciences which include science or natural science, engineering or applied science, and technology (Agustina, 2021). The combination of math with science, technology, and engineering in learning can be implemented through STEM (Science, Technology, Engineering, and Mathematics) learning. Various studies have proven its influence on students' understanding of mathematical concepts (Oktaviani et al., 2020).

STEM learning contains learning that combines four disciplines, which include science, technology, engineering, mathematics, and science (Mardhiyatirrahmah et al., 2020). STEM learning requires all four aspects at once to solve a problem in real life, so as to create a cohesive and active learning system (Gusna & Ngazizah, 2021). STEM is considered to have a good impact on improving students' understanding of mathematical concepts as well as the basis for developing students' 21st century skills. Through STEM learning, students are required to understand mathematical concepts by linking to concrete objects outside of mathematics.

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STEM learning aims to require students to be able to solve a problem, think creatively, and think critically (Dwita & Susanah, 2020). Through STEM learning, students are not only trained in terms of cognitive aspects but also affective, as well as skills, and students not only learn theory but also learn practice in it (Heryuriani & Musdayati, 2020). So that students can solve various problems that are often encountered in everyday life and are able to think critically, logically, and creatively. In addition, students can understand the basic concepts of mathematics as a provision for mastering 21st century skills.

One of the math materials that can be integrated with STEM learning is social arithmetic. The concept of social arithmetic is often encountered by students, for example related to calculating profit, loss, discount, netto, bruto, and tara. The concept of social arithmetic is closely related to buying and selling activities that are often carried out including activities to assess industrial products. Learning social arithmetic material using STEM learning can help students relate contret problems in everyday life. So that indirectly students build an understanding of mathematical concepts through meaningful learning. Therefore, this study aims to determine the effect of STEM learning on students' mathematical concept understanding ability and the improvement of students' mathematical concept understanding ability through STEM learning.

METHOD

This study uses a quasi-experimental research method that aims to determine the effect of Science Technology Engineering and Mathematics (STEM) learning method as an independent variable on students' mathematical concept understanding ability as the dependent variable. The research design used was the nonequivalent pretest-postest control group design. Researchers compared two groups of students, namely the experimental group and the control group, which were given different treatments, only the experimental group received learning with the STEM learning method. STEM learning was conducted on social arithmetic material in four stages. The stages of the STEM learning process are presented in Table 1.

Table 1. STEM Integration in Social Arithmetic Learning

Aspects/Steps	Students' Activities
Science	• Students can understand the concept of fermentation.
Technology	• Students can use facilities such as gadgets to make videos in the process of making cassava *tapai*. • Students can use the application either online or offline to edit the video results that students have made.
Engineering	• Students can determine which cassava is good for making *tapai*. • Students can engineer or design how to process cassava properly to make *tapai*. • Students can design a flyer or brochure for promotion.
Mathematic	• Students can understand about income and expenses. • Students can understand the sales price and purchase price. • Students can understand the profit and loss.

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The population in this study were seventh grade students in one of the junior high schools in Serang, Banten, Indonesia. The samples involved in this study were two groups selected using probability sampling technique. The first group as the experimental group consisted of 33 students while the other group with the same number as the control group. The two groups were given a pre-test to determine the initial condition of students' understanding of mathematical concepts before being given treatment and a post-test of understanding of mathematical concepts after treatment to determine the final achievement of learning as well as the improvement of students' understanding of mathematical concepts.

Data were collected using a mathematical concept understanding test consisting of 7 essay questions which included indicators of restating a concept that has been learned; classifying objects based on whether or not the requirements that make up the concept are met; applying concepts algorithmically; providing examples and non-examples of concepts that have been learned; presenting concepts in various mathematical representative forms; linking various mathematical concepts; and developing necessary conditions and a concept (Rosmawati & Sritresna, 2021). The test has been tested valid, reliable, has good differentiation, and has a medium level of difficulty.

While data analysis uses descriptive statistical analysis including N-Gain and inferential statistical analysis, namely the independent sample t-test to test the hypothesis. Before testing the hypothesis, researchers also conducted a prerequisite test, namely the normality test using the Kolmogorov-Smirnov criteria and the homogeneity test using the Levene criteria in SPSS. Meanwhile, the N-Gain value was classified with the interpretation of high with a value of $g > 0.70$, medium with a value of $0.70 \leq g \leq 0.30$, and low with a value of $g < 0.30$ (Herawati et al., 2013).

RESULTS AND DISCUSSION

The pre-test results showed that the mathematical concept understanding of the experimental group was higher than the control group, although the concept understanding of both classes was in the medium category, namely 57.23 for the experimental group and 28.80 for the control group. The post-test results also revealed that the average understanding of mathematical concepts of experimental group students was higher than the control group, namely 90.15 for the experimental group and 56.86 for the control group. Table 2 presents descriptive data of the post-test results of mathematical concept understanding of the experimental group and control group in full.

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Table 2. Descriptive Data of Post-Test Results of Mathematical Concept Understanding

Parameters	Experiment Group	Control Group
N	33	33
Sum of Scores	2975,00	1876,50
Average	90,15	56,86
Standart of Defiation	88,97	55,97
Varians	7676,95	3037,86
Maximum Score	100	80
Minimum Score	65	32,5

The post-test results were categorized into three levels, namely high (scores of 93 and above), medium, and low (scores below 54) to see the distribution of students' mathematical concept understanding levels (see Figure 1).

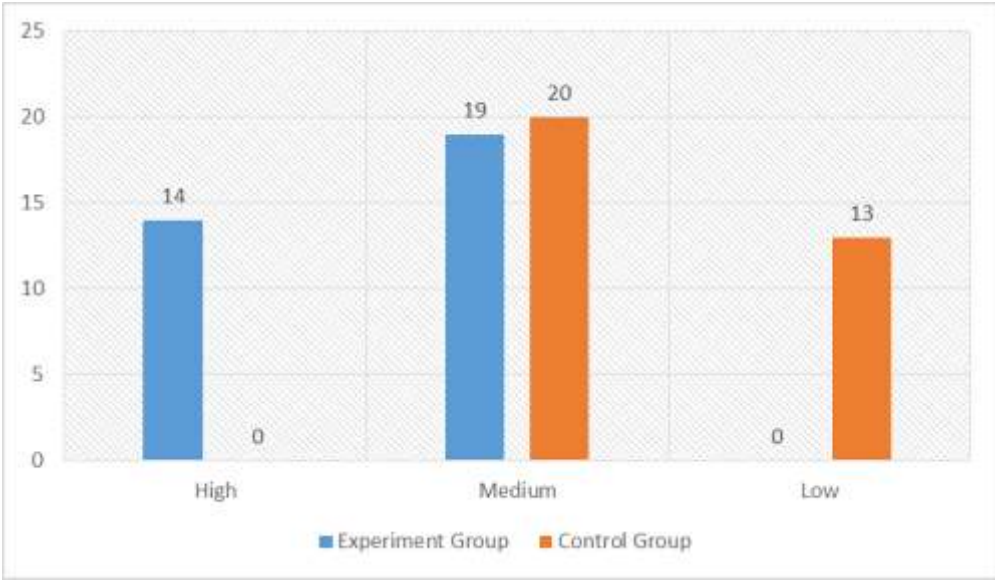

Figure 1. Comparison of Final Achievement of Students' Mathematical Concept Understanding

Figure 1 shows that both groups were dominated by students in the medium category. However, there is a striking difference in the number of students in the high and low categories, which contradicts each other between the experimental and control groups.

As a prerequisite for hypothesis testing, the normality test was conducted with the Kolmogrov-Smirnov test with a significance level of 5%. The results of the normality test on students' mathematical concept understanding data show that all data are normally distributed as shown in Table 3.

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Table 3. Normality Test Results of Students' Mathematical Concept Understanding

Groups	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
Experimet Pretest	.157	33	.038	.965	33	.366
Experimet Pretest	.135	33	.130	.902	33	.006
Control Pretest	.164	33	.024	.951	33	.140
Control Pretest	.111	33	.200*	.983	33	.877

Furthermore, the variance homogeneity test uses the Levene test with a significance level of 5%. Based on the results of the homogeneity test on the data of students' mathematical concept understanding ability, it is concluded that it has a homogeneous variance as shown in Table 4.

Table 4. Results of Variance Homogeneity Test of Students' Mathematical Concept Understanding

Parameters	Levene Statistic	df1	df2	Sig.
Based on Mean	.609	1	64	.438
Based on Median	.585	1	64	.447
Based on Median and with adjusted df	.585	1	58.723	.447
Based on trimmed mean	.586	1	64	.447

With the condition that the data is nomally distributed and homogeneous, then test the hypothesis with an independent sample t-test to determine the effect of STEM learning on students' understanding of mathematical concepts. The results of the Independent Samples Test are presented in Table 5.

Table 5. Independent Samples Test Results

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Difference	
								Lower	Upper
Equal var. assumed	.609	.438	13.929	64	.000	33.2879	2.3899	28.5135	38.0622
Equal var. not assumed			13.929	61.629	.000	33.2879	2.3899	28.5100	38.0658

Based on Table 5, it can be concluded that there is a significant effect of STEM learning methods on students' understanding of mathematical concepts. Or in other words, the STEM learning method has a positive impact on students' ability to understand mathematical concepts.

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To ensure the improvement of students' mathematical concept understanding, N-Gain calculation was conducted on both groups by comparing the average pre-test and post-test scores. The N-Gain calculation is presented in Table 6.

Table 6. N-Gain Score of Experimental Group and Control Group

Groups	Average of Pre-Test	Average of Post-Test	N-Gain Score	Categories
Experiment	57,23	90,15	0,79	Tinggi
Control	28,80	56,86	0,38	Rendah

The increase in mathematical concept understanding of experimental group students who received STEM learning was in the high category. This increase is much better than the increase in mathematical concept understanding of control class students who were given different treatments. The results of this study are in line with previous research which also shows that STEM learning has an effect on students' ability to understand mathematical concepts even though on different topics (Imeysa et al., 2021)..

The effectiveness of STEM learning on understanding mathematical concepts or learning outcomes in general has been confirmed by various previous studies, among others. The application of STEM learning varies, among others, combined with the *Relating, Experiencing, Applying, Cooperating, and Transferring* or REACT learning model (Rahmadhani et al., 2021) or combined with the *Thinking Aloud Paid Problem Solving* (TAPPS) strategy so that there is an increase in student activity and learning outcomes (Yanni, 2018).

In addition, research that combines STEM with the *Project Based Learning* (PjBL) model has also been shown to improve more complex mathematical abilities, such as students' creative thinking skills (Octaviyani et al., 2020), as well as affect students' mathematics learning outcomes in general (Widana & Septiari, 2021). STEM learning has been widely proven to be effective even though it is still in the research stage with a limited sample.

While in this research, especially on social arithmetic material, students do stages of learning that help students understand mathematical concepts. In the first stage, which is related to *science*, students are given questions about fermentation products found in everyday life, namely *tapai*. The question can lead students to observe and analyze critically and conceptually related to the relationship between material and daily life (Suryaningsih & Nisa, 2021). The teacher asks students to apply the fermentation material in the form of a cassava *tapai*-making project carried out in groups at one of the students' houses. At this stage, students understand mathematics as a science that has practical uses and is related to other sciences (Roehrig et al., 2021).

In the process of making cassava *tapai*, students have indirectly applied *technology*, for example by using cellphones to find information about the materials and tools that will be used to

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make the cassava *tapai*. Students also actively make videos during the manufacturing process using cellphones and use certain applications to edit videos and brochures or advertisements to promote fermented products that are successfully made. Students' proficiency in carrying out project stages systematically helps students train their ability to apply algorithms (Kanaki & Kalogiannakis, 2022).

At the *engineering* stage, students can engineer or decide which cassava is best for making *tapai*, how to process cassava properly so that it becomes a good cassava *tapai*, and design brochures and promotional advertisements. This stage trains students to use various representations (DiPaola et al., 2020). Finally, at the *mathematics* stage, students calculate how much capital students spend, income earned, and profit or loss. Indirectly, in calculating capital, income, and the difference, students have applied social arithmetic material (Majeed et al., 20221). At this stage students strengthen their understanding of mathematical concepts, restate concepts according to their understanding, use algorithms in calculating, distinguish profits and losses, and make appropriate representations.

CONCLUSION

The Science, Technology, Engineering, and Mathematics (STEM) learning approach significantly enhances comprehension of mathematical concepts, particularly in social arithmetic. STEM learning stages prompt students to connect mathematics with real-life issues, especially those related to social arithmetic. In implementing STEM learning, careful allocation of learning time is crucial to ensure all students can complete each stage of the learning process effectively. Furthermore, there remains ample opportunity for researchers to explore and utilize STEM learning methods across various mathematics topics in school settings, thereby enhancing the overall quality of mathematics education.

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