e-ISSN: 2549-5070
p-ISSN: 2549-8231

Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang
Volume 7, No. 1, 2023, pp. 45 - 56

https://doi.org/10.31331/medivesveteran.v7i1.2240

The Effect of Learning Science, Technology, Engineering, and Mathematics (STEM) on the Ability to Understand the Material Concepts of Lines and Angles

*Anggini Dinda Nursafitri[1], Nurul Anriani[2]
[1, 2] Universitas Sultan Ageng Tirtayasa
*2225180086@untirta.ac.id

***Received**: July 2022. **Accepted**: August 2022. **Published**: January 2023.*

ABSTRACT

This research is motivated by the low ability to understand mathematical concepts of junior high school students. One effort to improve students' ability to understand mathematical concepts is to use a Science, Technology, Engineering, and Mathematics (STEM) learning approach that encourages students to be able to open their mindsets to finding new knowledge, developing creativity, and making students active explorers by doing the mathematical activities directly with the facilities prepared by the teacher during the learning process. This research was conducted at SMP Negeri 21 Serang in 2021/2022 and aims to determine the effect of learning Science, Technology, Engineering, and Mathematics (STEM) on the ability to understand mathematical concepts of junior high school students online and angle material. The research method used in this study is a quasi-experimental design with the nonequivalent pretest-posttest control group type of design. This study involved two classes consisting of experimental and control classes. The sample of this study was class VII D, which consisted of 30 students as the experimental class, and VII A, which consisted of 30 students as the control class. The experimental class applies the STEM learning approach, and the control class applies conventional learning. The instrument used is in the form of a test description of the ability to understand mathematical concepts. The data from this study were analyzed using descriptive statistics and inferential statistics. Based on the research results, the final achievement and improvement of students' ability to understand mathematical concepts using the STEM learning approach in learning mathematics are better than students using conventional learning. Thus, the Science, Technology, Engineering, and Mathematics (STEM) learning approach can be applied to improve junior high school students' ability to understand mathematical concepts.
***Keywords**: Ability to Understand Mathematical Concepts, Science, Technology, Engineering, and Mathematics (STEM) Learning Approach*

How to Cite: Nursafitri, A., & Anriani, N. (2023). The Effect of Learning Science, Technology, Engineering, and Mathematics (STEM) on the Ability to Understand the Material Concepts of Lines and Angles. *Journal Of Medives : Journal Of Mathematics Education IKIP Veteran Semarang*, *7*(1), 45 - 56.

INTRODUCTION

The development of a country must be connected to the development of education. Education is an essential aspect of human life. Through education, humans acquire knowledge that can be used as guidance in everyday life. Education carried out by each individual can provide knowledge, understanding, insight, skills, and specific expertise to shape character and develop their abilities actively and productively to achieve a goal. The action needed to realize the goals of education is to implement education in each academic unit through effective learning activities to increase the mastery and development of knowledge. One of the scientific developments in question is mathematics education.

Mathematics (mathematics) is one of the basic sciences used as a reference for other disciplines. In everyday life, learning mathematics is inseparable from the problems humans often face to solve (Agnesti & Amelia, 2021). Learning mathematics encourages students to think logically, analytically, thoroughly, and rationally in drawing conclusions based on data and rules. Therefore, learning mathematics is more than just learning to memorize the concepts taught by the teacher. Still, learning mathematics is done by instilling concepts in students to produce a meaningful learning process with a complete understanding perception because it can be understood properly.

However, in reality, what is happening in schools, there are still many students who do not like learning mathematics. They even think of mathematics as one of the subjects that must be avoided and feared at school, both at the primary and secondary education levels. This is because teachers do not involve students in learning mathematics at school. To achieve better learning outcomes, the role of the teacher is needed in encourage students to be able to open their mindset in finding new ideas and knowledge, developing student creativity, and making students active explorers (active explorers) who can lead to an understanding of students' mathematical concepts during the learning process takes place. The connection of students who actively play a role in the process of learning mathematics must also be provided with certain learning activities that can guide students to find and obtain information about the relationship between various knowledge and build an understanding of mathematical concepts so that students can carry out mathematical activities (doing math) directly with the facilities provided by the teacher. Therefore, the ability to understand mathematical concepts should be instilled by the teacher so that students can apply the concepts well in the process of learning mathematics.

Understanding the concept (conceptual understanding) is a mathematical ability with regard to ideas or ideas that must be understood, applied, and mastered by students in learning mathematics. The student's ability to understand concepts can be seen from their ability to (1) restate a concept, (2) identify and make examples and non-examples of a given concept, (3) use models, diagrams, and symbols to represent a concept, (4) changing one form of representation to another, (5) applying concepts or algorithms in solving problems, (6) identifying the characteristics of a concept and recognizing the necessary or sufficient conditions of a concept, and (7) relate a concept to other concepts. According to NCTM (Ningrum et al., 2019) states that the rational importance of the ability to understand mathematical concepts includes those listed in the 2013 Curriculum mathematics learning objectives. Understanding of mathematical concepts will develop if the teacher can explore learning topics in-depth and provide appropriate, interesting, and appropriate examples. Linking learning with the concepts of other disciplines. This is because the concepts in mathematics are related to one another. The teacher provides opportunities for students to see the connections between mathematics and other material and constructs mathematical concepts so that students are able to understand and understand mathematical material in depth and can apply concepts. - these concepts are flexible, accurate, precise, and efficient in the process of learning mathematics.

Based on the results of an interview with one of the class VII mathematics educators of SMP Negeri 21 Kota Serang, he said that students still had difficulty understanding mathematical concepts and solving math problems which were still relatively low. In addition, educators also say that often students can solve math problems correctly and correctly as conveyed by the teacher, but when given questions with different levels of difficulty, students cannot solve them. Because students can only solve math problems as exemplified by the teacher.

In line with this, research conducted by (Hidayah, 2018) said that the ability to understand mathematical concepts of junior high school students is still relatively low. The low ability to understand students' mathematical concepts affects the process of learning mathematics. Ali Ardhi (Aida et al., 2017) concluded that junior high school students' conceptual understanding abilities were still not satisfactory. In the learning that has been carried out so far, it has not been able to develop the ability to communicate students' mathematical ideas appropriately, develop students' ability to understand mathematical concepts and develop students' mathematical problem-solving abilities.

The low ability to understand students' mathematical concepts can be caused by several factors, both external factors of the teacher and internal factors of students. External factors that come from outside the student's self, such as the learning method or strategy used. Meanwhile, internal factors come from within students, such as emotions and attitudes toward mathematics.

The importance of understanding concepts in learning mathematics can be seen in how the teacher conveys the subject matter and teaches these concepts so that students can easily understand them. Active involvement of students can provide a better understanding because students are encouraged to better understand and understand what they are doing

(Nugraheni, 2013). However, the ability to understand mathematical concepts is still not as expected. In the learning process, students have not been encouraged to develop their ability to understand concepts, so students prefer to memorize the concepts and principles of the elements contained in the mathematical material rather than understand mathematical concepts.

Learning mathematics in the classroom only directs students to the ability to use formulas, memorize formulas, work on problems, and they are rarely taught to analyze and use mathematics in everyday life. Therefore, there is a need for learning innovations that can actively involve students in the learning process and are able to help students understand a concept from a material. One of the efforts made is the implementation of the STEM approach in the learning process, especially in learning mathematics at school.

STEM (Science, Technology, Engineering, and Mathematics) is a learning approach that is formed based on a combination of several disciplines, including science, technology, engineering, and mathematics. Collaboration of several disciplines in the STEM learning process will help students to collect, analyze, and solve problems that occur and be able to understand the relationship between a problem and other problems (Nessa et al., 2017). One of the goals of STEM learning is to grow the ability to understand mathematical concepts and students' thinking skills in solving problems. STEM is considered capable of involving various concrete and abstract contexts at one time because of the integration of various aspects that make mathematics that was originally abstract become concrete. This can attract the attention of mathematics teachers in helping students who have learning difficulties or difficulties in understanding mathematical concepts.

STEM learning has the potential to train students' understanding skills in solving problems through a project that is integrated with one or several other disciplines. The STEM approach that is currently developing is an innovation in the world of education in Indonesia. STEM is assessed according to the 2013 Curriculum (Gustiani et al., 2017). Learning that is carried out through the STEM approach guides students not only in memorizing mathematical formulas but rather how students understand mathematical concepts and their relation to learning mathematics in everyday life. In addition, teachers can discuss ideas that link content with other ideas and how a transdisciplinary problem-solving approach can be used to provide students with conceptual understanding as well as exploration, assessment, interpretation, synthesis, and information. STEM uses a problem as a first step in collecting and integrating new knowledge based on experience in real activities (Indriani, 2020).

One example of the application of mathematics in everyday life that is often encountered is lines and angles. Lines and angles are one of the materials contained in the 2013 Curriculum at the Junior High School (SMP) level, which is taught to students of class VII even semester. By learning using the STEM approach, it is hoped that it can provide students with the ability to understand mathematical concepts regarding the material lines and angles and students are able to create learning media that are applied to the mathematics learning process so that students are able to interpret more deeply the importance of mathematics for science, engineering, and technological development.

Based on this description, researchers are interested in knowing how STEM learning affects students' ability to understand mathematical concepts in the material lines and angles and aims to find out the difference in increasing the ability to understand mathematical concepts using STEM learning.

METHODS

This research was conducted at SMP Negeri 21 Kota Serang. The population in this study were all class VII students at SMP Negeri 21 Kota Serang in the even semester of the 2021/2022 academic year, which consisted of five classes with a total of 172 students. Sampling in this study was carried out by *random cluster sampling*, a random sampling technique with cluster differences. Obtained class VII D as an experimental class with a total of 30 students and class VII A as a control class with a total of 30 students.

This research is included in the type of quantitative research. The method used in this research is a *quasy experiment*. The type of design used in this study is *The Nonequivalent Pretest-Postest Control Group Design*. There are two groups used in this design, namely the experimental class (trial class) and the control class (comparison class), in which each class is given treatment with a different learning approach. Then the effect will be seen due to the treatment given after the learning process is conducted. The experimental class will be treated using learning with the *Science, Technology, Engineering and Mathematics* (STEM) approach. In contrast, the control class will be treated using conventional learning. To find out students' conceptual understanding abilities before and after the implementation of the learning process, an initial test (*pretest*) and a final test (*posttest*) were carried out. The design form of *The Nonequivalent Pretest-Posttest Control Group,* according to (Nurhayati et al., 2020), can be seen in Table 1.

Table 1. Research Design

Group	Pretest	treatment	Posttest
Experiment	O	X	O
Control	O		O

Information:
O: *pretest/posttest* ability understanding of the concept of experimental class and control class
X: *treatment* (treatment) in class experiment

This study consists of two variables, namely one independent variable and one dependent variable. The independent variable in this study is learning using the *Science, Technology, Engineering, and Mathematics* (STEM) approach. In contrast, the dependent variable in this study is the ability to understand students' mathematical concepts.

Collecting data in this study used written test instruments in the form of *essay questions* at the beginning of learning (*pretest*) and the end of learning (*posttest*). To determine the instrument's quality, it is necessary to carry out instrument trials, namely validity tests, reliability tests, differentiating power tests, and difficulty level tests.

The data analysis technique used in this research is descriptive statistics and inferential statistics. In inferential statistics, data are analyzed using prerequisite tests and hypothesis tests. The prerequisite test consists of a normality test and a homogeneity test. The normality test used in this study is the *Kolmogorov-Smirnov* (KS) test, while the homogeneity test uses the F test. In addition, this study uses hypothesis testing with the t-test and *n-gain test*, which aims to determine the increase in learning outcomes and measure how the extensive understanding of students' concepts in the experimental class and control class after learning was carried out by analyzing the average *pretest* and *posttest average scores*. To determine the normalized *n-gain value*, use the formula according to Hake (Herdiman, 2017) :

$$N - Gain\ (g) = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}}$$

Information:
S_{pre} *pretest* average score
S_{post} : the average score of the *posttest*
S_{maks} : maximum score

With interpretation (Herdiman, 2017) which can be seen in Table 2.

Table 2. Normalized N-Gain Interpretation

N-Gain Index	Interpretation
$G \geq 0{,}7$	Tall
$0{,}30 \leq G < 0{,}69$	Currently
$G < 0{,}3$	Low

RESULTS AND DISCUSSION

Before the learning process with the STEM and non-STEM approaches was carried out in both classes, namely the experimental class and the control class, an initial test (*pretest*) was held to obtain data on students' initial abilities before being given *treatment*. Data from the initial test (*pretest*) ability to understand mathematical concepts is presented in Table 3.

Table 3. *Pretest Data Analysis*

Group	Average
Experiment	47.98
Control	41.91

Based on Table 3, it can be seen that the average value of the initial test (*pretest*) of the ability to understand mathematical concepts that have been carried out in the experimental class has a higher value compared to the average value of the initial test (*pretest*) of ability to understand mathematical concepts that have been carried out in class control. Where for the experimental class, namely class VII D, obtained an average value of 47.98, and the control class, namely class VII A, obtained an average value of 41.91. However, even the average value of the pretest (*pretest*) obtained in the experimental class is higher than the average value of the pretest (*pretest*) obtained in the control class. The next measurement is to carry out prerequisite tests, namely the normality test and homogeneity test.

This aims to determine whether the two classes are normally distributed and homogeneous. If the normality test and homogeneity test are fulfilled by showing that the data is normally distributed and has the same (homogeneous) variance.

After the prerequisite test data showing that both data are normally distributed and homogeneous are collected, then data analysis can be carried out to test the hypothesis. Testing the hypothesis using the two average similarity test. The statistical formula used is the parametric t-test formula. The reason why the t-test is used in the *pretest* is to find out whether there are differences in the ability to understand students' mathematical concepts. If there is no difference, it can be concluded that students have the same or average initial ability.

The results of the initial test data hypothesis test (*pretest*) can be seen in Table 4.

Table 4. Initial Test Data Hypothesis Test (*Pretest*)

		Pretest	
		Equal Variances Assumed	***Equal Variances note Assumed***
t-test for Equality of Means	t	2,971	2,971
	df	58	54,024
	sig. (2-tailed)	0.004	0.004

Based on the results of the initial test hypothesis test (*pretest*) ability to understand students' mathematical concepts in the material lines and angles can be seen that the significance value is 0.165. This means that at the significance level $\alpha = 0,05$, the data has a homogeneous variance. In the experimental class and the control class, the *sig.* (*2-tailed*) of 0.004 less than 0.05. This means H_0rejected and H_1accepted. The results of the similarity of the two average *pretest data* in the experimental class and the control class were not significantly different. Thus it can be concluded that the two classes, the experimental class and the control class, can be given different *treatment*.

After that, the next step is to give treatment *to* each sample class, namely the experimental class and the control class. Class VII D as the experimental class applies to learning with a *Science, Technology, Engineering, and Mathematics* (STEM) approach while class VII A as the control class applies conventional (non-STEM) learning.

In the learning process in the experimental class, the implementation of learning with the STEM approach consists of four aspects. Analysis of planning the learning process with the STEM approach is presented in Table 5.

Table 5. STEM Integration in Line and Angle Learning

Indicator	**Material Integration**
Science	a. Students can understand the concept of quantity and measurement
Technology	a. Students can utilize technology in designing bridges
Engineering	a. Students can make products according to the design b. Students can determine the selected material so that the raft can function properly
Mathematics	a. Students can understand the concept of angles formed in the framework of a bridge b. Students can apply the concept of the relationship between two angles formed by two parallel lines cut by a transverse line in designing a bridge c. Students can understand the types of angles and their consequences in bridge design through resistance exploration

Based on Table 5 the learning process with the STEM approach is described as follows, in the first aspect as a process related to *Science* , namely students are guided to observe, identify, ask and communicate problems critically and conceptually from a phenomenon that occurs in everyday life. The teacher asks questions about problems related to rivers and bridges that are often encountered in everyday life. These questions are able to guide students to observe and analyze problems related to rivers and crossings in Indonesia.

The teacher asks the students to apply the material of magnitude and measurement in the form of a project by making a miniature bridge. The second aspect is a process related to *Technology*, namely by utilizing technology in the form of *cell phones* in designing bridges. The third aspect is a process related to *Engineering*, namely, students can analyze engineering and determine the selected material so that the raft can function properly. The fourth aspect is a process related to *Mathematics*, namely, students understand the concept of angles formed in the framework of a bridge and apply the concept of the relationship of two angles formed by two parallel lines cut by a transversal line in designing a bridge. The integration of aspects of *Science*, *Technology*, *Engineering*, and *Mathematics* in mathematics learning can encourage students to better master concepts and make the learning process more meaningful.

Meanwhile, in the learning process in the control class, the implementation of learning is conventional (non-STEM) learning. Conventional learning uses the lecture method. This learning is centered on the teacher (*teacher-centered*) , where the teacher conveys and explains learning materials, while students only listen and record teacher explanations so that they do not motivate and encourage students to increase activity in learning mathematics.

After the learning process with the STEM and non-STEM approaches was carried out in both classes, namely the experimental class, and the control class, then a final test (*posttest*) was given to find out the student's final ability data after carrying out the learning process in the two sample classes. Data on the results of the final test (*posttest*) on the ability to understand mathematical concepts are presented in Table 6.

Table 6. *Posttest Data Analysis*

Group	**Average**
Experiment	82.02
Control	59,76

Based on Table 6 it can be seen that the *posttest* score with the highest score in the experimental class is 100 and the control class is 85.71, while the lowest score for the experimental class is 50 and the control class is 39.29. The measure of central tendency which includes the average value of the final test (*posttest*) ability to understand mathematical concepts in the experimental class obtained a higher score compared to the average value of the final test (*posttest*) ability to understand mathematical concepts in the control class, with a difference of 22.26 . The next measurement is to carry out prerequisite tests, namely the normality test and homogeneity test. This aims to determine whether the two classes are normally distributed and homogeneous. If the normality and homogeneity tests are fulfilled by showing the data is normally distributed and has the same (homogeneous) variance.

After the prerequisite test data showing that both data are normally distributed and homogeneous are collected, then data analysis can be carried out to test the hypothesis. Testing the hypothesis using the two average similarity test. The statistical formula used is the parametric t-test formula. The reason why the t-test is used in the *posttest* is to find out whether there are differences in the final achievement of students' ability to understand mathematical concepts. If there is no difference, it can be concluded that students have the same or average achievement in understanding mathematical concepts.

The results of the final test data hypothesis test (*posttest*) can be seen in Table 7.

Table 7. Hypothesis Test Data Final Test (*Posttest*)

		Posttest	
		Equal Variances Assumed	***Equal Variances Note Assumed***
t-test for Equality of Means	t	6,563	6,563
	df	58	57,972
	sig. (2-tailed)	0.000	0.000

Based on the results of the final test hypothesis test (*posttest*) the ability to understand students' mathematical concepts in the material lines and angles can be seen that the value is significant is 0.827. This means that at the significance level $\alpha = 0{,}05$, the data has a different variance. In the experimental class and the control class, the *sig.* (*2-tailed*) of 0.000 less than 0.05. This means H_0 rejected and H_1 accepted. Thus it can be concluded that there are differences in the final achievement of students' ability to understand mathematical concepts in the two sample classes given different *treatments*. The experimental class applies to learning with the STEM approach and the control class applies conventional (non-STEM) learning.

Furthermore, the data on the initial test scores (*pretest*) and final test scores (*posttest*) that have been obtained from the experimental class and the control class can determine how much the students' ability to understand mathematical concepts in the two sample classes has increased with the normalized gain formula (*N-gain*). *N-gain* result data (increase) ability to understand mathematical concepts is presented in Table 8.

Tabel 8. *N-Gain* Data Analysis

Group	**Average**
Experiment	67,94
Control	31,22

Based on Table 8 it can be seen that the *N-gain* value with the highest score in the *experimental* class is equal to 100 and the control class is equal to 69.22, while the lowest value for the experimental class is equal to 30 and the control class is equal to 0. the experimental class has an average a higher increase compared to the control class with a difference of 36.72 which can be said that there is a significant difference between the increase in the experimental class and the control class. It can be seen that *the N-gain* in the experimental class and control class has a moderate interpretation.

However, in the experimental class the increase in the ability to understand mathematical concepts was more significant than in the control class. This shows that the diversity of *N-gain data for* the experimental class is more varied than the control class. This means that there are some students in the experimental class who get quite high *N-gain.* Based on these data, descriptively it appears that although there is an increase in the ability to understand mathematical concepts in the control class, the increase is not as big as the increase in the ability to understand concepts in the experimental class. So it can be concluded that the experimental class is better than the control class.

After the prerequisite test data showing that both data are normally distributed and homogeneous are collected, then data analysis can be carried out to test the hypothesis. Testing the hypothesis using the two average similarity test. The statistical formula used is the parametric t-test formula. The reason why the t-test is used on *n-gain* (increase) is to answer the problem. Hypothesis testing uses the similarity of two averages, the statistical formula used is the parametric t-test formula. The research hypothesis is as follows:

H_0 : increasing the ability to understand mathematical concepts of students who use learning with the STEM approach is not better than conventional learning (non-STEM)

H_1 : increasing the ability to understand mathematical concepts of students who use learning with the STEM approach is better than conventional learning (non-STEM)

With the test criteria are as follows:

If the probability value is $(Sig) > 0{,}05$, then it is H_0 accepted

If the probability value is $(Sig) < 0{,}05$, then it is H_0 rejected

The results of the increased data hypothesis test (*N-gain*) can be seen in Table 9.

Table 9. Hypothesis Test *of N-Gain Data*

		N-Gain	
		Equal Variances Assumed	***Equal Variances note Assumed***
t-test for Equality of Means	t	6,877	6,877
	df	58	57,761
	sig. (2-tailed)	0.000	0.000

Based on the results of the hypothesis test increasing (*N-gain*) the ability to understand students' mathematical concepts in the matter of lines and angles, it can be seen that the significance value is 0.845. This means that at the significance level $\alpha = 0{,}05$, the data has a different variance. In the experimental class and the control class, the *sig.* (*2-tailed*) of 0.000 less than 0.05. This means H_0rejected and H_1accepted.

This shows that the increase in the ability to understand students' mathematical concepts in the experimental class is better than conventional learning in the control class. The results of improving students' understanding of mathematical concepts showed that the *n-gain value* in the experimental class had high criteria, while the *n-gain value* in the control class had moderate criteria. Thus it can be seen that the increase in the ability to understand students' mathematical concepts in the experimental class is better than the increase in the ability to understand students' mathematical concepts in the control class.

This is certainly consistent with the research hypothesis and theories previously described that learning using the *Science Technology Engineering and Mathematics* (STEM) approach can result in students' ability to understand mathematical concepts in the experimental class better than the ability to understand mathematical concepts in the control class. using conventional learning (non-STEM). These results are in accordance with research conducted by (Nurfarida, 2019) which results that learning using the *Science Technology Engineering and Mathematics (STEM) approach with the help of puzzle* learning media is better than students using conventional learning on the ability to understand mathematical concepts.

In addition, research conducted by (Yanni, 2018) which resulted that the application of the *Thinking Aloud Paid Problem Solving* (TAPPS) strategy based on the STEM approach can improve students' mathematics learning activities which are of a higher quality and can improve student learning outcomes.

Based on the explanation above, it can be concluded that learning using the *Science, Technology, Engineering, and Mathematics* (STEM) approach in the mathematics learning process can train students to play an active and creative role in finding solutions to problems given in groups and help students in improve mastery of students' ability to understand mathematical concepts of learning material. Thus, learning using the *Science, Technology, Engineering, and Mathematics* (STEM) approach is better than conventional learning (non-STEM) so learning using the *Science, Technology, Engineering, and Mathematics* (STEM) approach has a positive influence on comprehension abilities of students' mathematical concepts.

CONCLUSION

Based on the results of data analysis and hypothesis testing that has been carried out, it is concluded that the final achievement and improvement of students' understanding of mathematical concepts using the *Science, Technology, Engineering, and Mathematics* (STEM) learning approach is better than using conventional learning (Non STEM). For future researchers, it is hoped that they can apply research to other materials, to find out whether learning with the STEM approach is good for all mathematical problem-solving and can make this research a reference for carrying out research that has a relationship with this research.

BIBLIOGRAPHY

Agnesti, Y., & Amelia, R. (2021). Factors of Student Learning Difficulties in Comparative Material Using a Contextual Approach. *Mosharafa: Journal of Mathematics Education* , *10* (2), 311–320. https://doi.org/10.31980/mosharafa.v10i2.868

Aida, N., Kusaeri, K., & Hamdani, S.

(2017). The Characteristics of the Cognitive Domain Mathematics Learning Outcomes Assessment Instrument Developed Referring to the PISA Model. *Suska Journal of Mathematics Education* , *3* (2), 130. https://doi.org/10.24014/sjme.v3i2.3897

Gustiani, I., Widodo, A., & Suwarma, IR (2017). Development and validation of science, technology, engineering and mathematics (STEM) based instructional materials. *AIP Conference Proceedings* , *1848* (May). https://doi.org/10.1063/1.4983969

Herdiman, I. (2017). Application of an Open-Ended Approach to Improve the Mathematical Reasoning of Junior High School Students. *JES-MAT (Journal of Education and Mathematical Science)* , *3* (2), 195. https://doi.org/10.25134/jes-mat.v3i2.691

Hidayah, M.A. Al. (2018). *The application of the guided discovery method with the help of student worksheets on lines and angles with a portfolio assessment in improving students' conceptual understanding of class VII* . *1* (1), 32–42.

Indriani, KWA (2020). On Flat Shape Material Through the Stem Integrated Project Learning Model. *Mathematics Education* , *8* (1), 51–62.

Nessa, W., Hartono, Y., & Hiltrimartin, C. (2017). Development of Student Books on Distance Material in Three Dimensional Space Based on Science, Technology, Engineering, and Mathematics (STEM) Problem-Based Learning in Class X. *Journal of Elements* , *3* (1), 1. https://doi.org/10.29408/jel.v3i1.273

Ningrum, QP, Febriani, NF, & Nopitasari, D. (2019). *Self-Efficacy Analysis of Students in the Problem Possing Setting Cooperative Learning Learning Method Team Assisted Individualization (TAI) Type* . *0812* (2019), 147–154.

Nugraheni, EA (2013). The Effect of the PMRI Approach on Junior High School Students' Activities and Understanding of Mathematical Concepts. *Pythagoras: Journal of Mathematics Education* , *8* (1), 101–108–108. https://doi.org/10.21831/pg.v8i1.8498

Nurfarida, R. (2019). *The influence of the learning media-assisted stem learning model* . 1–79. http://repository.radenintan.ac.id/6653/1/Skripsi Full.pdf

Nurhayati, Y., Zakiah, NE, & Amam, A. (2020). Contextual Teaching Learning (Ctl) Integration With Geogebra: Can It Improve Students' Mathematical Connection Ability? *Theorem: Mathematical Theory and Research* , *5* (1), 27. https://doi.org/10.25157/teorema.v5i1.3349

Yanni, MH (2018). Mathematics Through Approach-Based Tapps Learning Strategy (Stem). *Journal of Mathematics Education (Judika Education)* , *1* (2).