



The Effect of STEM Model Based on Bima's Local Cultural on Problem Solving Ability

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In STEM, learning skills and knowledge are learned simultaneously by students. Things that are different from the STEM aspect will require a connecting line that makes the four disciplines studied and applied simultaneously in learning. The utilization of local cultural characters in the STEM learning model is expected to provide solutions to the low ability of students to solve mathematical problems. Through this local culture-based STEM model, students are invited to get to know the richness of their culture and understand its relationship with mathematics subject matter geometry and learn to find problems, plan solutions, and solve their problems. This study aims to analyze the effect of STEM learning based on Bima's local cultural on problem solving ability. This research is experimental. The samples of this research were 2 class X students of SMA Negeri. The instrument used in this research is a test of geometric problem-solving abilities, in the form of an essay test scattered on each sub-concept and indicator tested. The data analysis technique uses the pooled variance t-test. The results showed that the value of t count is more than t table or $t_{obs} = 8,150 > t_{0,05,48} = 2,013$ so that H_0 is rejected. So, it can be concluded that the Science, Technology, Engineering, and Mathematics (STEM) learning model based on Bima's local cultural affect the problem-solving ability. Based on results, the researchers recommended adopting the STEM based on Bima's local cultural learning model in the teaching and learning process, in addition, further researchers can measure students' abilities on other dependent variables.

Keywords: STEM, bima local cultural character, problem solving, geometry, problem solving ability

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INTRODUCTION

The reality that has occurred about the quality of education in Indonesia has decreased. The 2018 Program evidences this for the International Student Assessment survey results that Indonesia is ranked 72 out of the 78 participating countries. Refers to the opinion of A. Schleicher (2019); The OECD (2019) states that the results are based on these data that the quality of education in Indonesia is still far from expected, so that problem-solving skills need to be developed, especially for high school students.

The ability to solve mathematical problems is an urgent matter to be studied. This refers to the opinion of P. M. Björn, K. Aunola, and J.-E. Nurmi (2016); S. Mafulah and D. Juniati (2020); Safrudiannur and B. Rott (2019); I. Isaacs (1999), because the field facts show that problem-solving ability is the general goal of teaching mathematics. Especially in geometry, problem-solving, which includes methods, procedures, and strategies, is a core and primary process in the mathematics curriculum, and problem-solving is an essential skill in learning. Therefore, it is necessary to develop problem-solving abilities. The opinion that the ability to solve problems, especially in geometry lessons that students have, can improve the quality of education in Indonesia K.-C. Yu, S.-C. Fan, and K.-Y. Lin (2015); F. Ke and K. M. Clark (2020).

Initial observations were made at one of the Senior High Schools (SMA) in Bima Regency for one week. Comments are focused on three aspects. Namely, students' mathematical problem-solving abilities, teacher learning models and methods, and the learning media used. In terms of mathematical problem-solving abilities, the data show that; 1) the students' ability to understand mathematics problems was still classified as moderate with an average percentage of 45.8%. 2) the students' ability to plan problem plans was low, with an average percentage of 31.6%. (3) the students' ability to complete plans was classified as low with an average percentage of 18.2%, and (4) the students' ability to re-check procedures and completion results was low with an average percentage of 16.4%. The percentage of the four items represents all the material in the math class X class at the high school. If it is divided explicitly into geometry material, for the four items, the average percentage of students' problem-solving abilities is in a low category, namely 17.4%.

Furthermore, the second is that observations are made of teachers' teaching models and methods in the classroom. The results show that using learning models and methods in general and conventional with steps, namely: providing material, giving sample questions, doing practice questions in textbooks, students are working on the blackboard, giving assignments. This step is carried out continuously and is monotonous for all mathematics subject matter for one semester or even one year. Can see that teachers are more focused on teaching in the classroom and never take the initiative to change teaching patterns, use other or new learning models, and provide a different learning atmosphere for students, for example, teaching outside the classroom

Third, the results of observations of the learning media used show that textbooks are the mainstay of learning media by teachers when teaching their students. Its use also rarely combines it with teaching aids or learning based on the natural surroundings. As a result,

student learning takes place conventionally and is less meaningful, so that it affects initiatives in solving problems in mathematics learning.

These observations are at least a fundamental reason why students in these high schools do not have good mathematical problem-solving skills. Students can only solve questions that have an easy and medium level but cannot solve problems that have a problematic group, such as a story problem that consists of several stages of completion. The teacher rarely invites students to be directly involved with nature when learning mathematics material, which is also a factor that indirectly affects students' problem-solving abilities, especially in geometry material. In teaching junior high school mathematics geometry material, the teacher should try to relate it to concrete objects in students' real life so that learning is more meaningful and is directly involved with the natural surroundings. If so, students are invited to observe, find problems, plan solutions, even solve problems independently of the issues and facts they observe.

Departing from the above problems, the solution offered by the researcher to solve the problem of students' geometry problem-solving ability is by developing a learning model that invites students to unite with nature, learn to find, plan solutions and solve problems. The learning model deemed appropriate is the Science, Technology, Engineering, and Mathematics (STEM) Learning Model. The opinion for researcher the novelty, the development of the STEM learning model, is deliberately designed (Y. Li and A. H. Schoenfeld (2019); K. Goodnough, S. Azam, and P. Wells (2019); N. Changtong, N. Maneejak, and P. Yasri (2020); S. J. Seage and M. Türegün, (2020)).

Utilization of the STEM learning model is expected to provide solutions to the low ability of students to solve mathematical problems. Through the STEM Learning Model, students are invited to get to know the richness of their culture and understand its relationship with mathematics subject matter geometry and learn to find problems, plan solutions, and solve their problems. In addition, students are expected to create related technology and mathematical design formulas that are used as facilities for problem-solving. The researcher's opinion states that learning is focused on the natural world and authentic problems so that students learn to reflect on the problem-solving process. STEM learning makes students have profound insights and are dynamic and creative to create a superior generation. (N. C. Siregar, R. Rosli, S. M. Maat, and M. M. Capraro (2019); N. S. M. Rasid, N. A. M. Nasir, P. Singh, and C. T. Han (2020); E. A. Firat (2020)).

In general, this STEM learning model provides full opportunities for students to explore, especially buildings, objects, and equipment used by the community in everyday life and finding points of contact with the geometry material being studied. When students have been able to find relationships, they can easily understand problems, design solutions, develop formulas and solve problems directly related to geometric material. The something that is of urgency in this study, namely students are expected; 1) able to understand mathematical concepts concretely with their ability to solve problems through STEM learning; 2) have apparent problem-solving abilities. Appreciate the usefulness of mathematics in everyday life to arouses curiosity and motivate me to study mathematics.

Literature Review

Learning Science, Technology, Engineering, and Mathematics (STEM)

In STEM, learning skills and knowledge are learned simultaneously by students. Things that are different from the STEM aspect will require a connecting line that allows the four disciplines to be studied and applied simultaneously in learning. STEM learning is interdisciplinary learning to learn various academic concepts juxtaposed with the natural world using science, mathematics, engineering, and technology. Refers to opinion for the researcher, connects schools, communities, jobs, and the global world provides space for the development of STEM literacy and can compete in the new economic world (S. J. Seage and M. Türegün (2020); R. P. Harper, T. J. Weston, and E. Seymour (2019); K. Maass, V. Geiger, M. R. Ariza, and M. Goos (2019). As a typology, integration in STEM learning can be classified as content integration, pedagogical integration and learner integration (Cheng & So, 2020). Students are expected for a career in the STEM field to move from a consumer position to a producer position by acquiring some skills through STEM education (Kanadli, 2019). The relationship between science, technique, technology, and mathematics is science gives way or tool to estimate the characteristics of things or materials through science concepts used in technique in solving practical problems producing a product called

Technology (Wahyu, et al 2020).

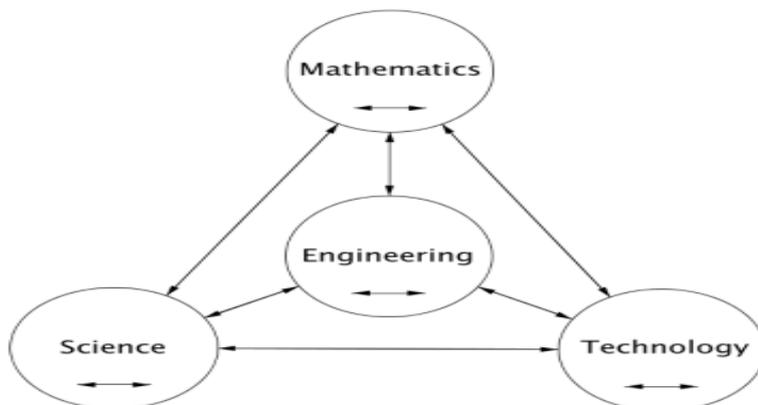


Figure 1
STEM learning model (Glancy & Moore. 2013)

Local Cultural Characteristics of Bima

Local cultural character is something that is inherited or learned to change something new for the educational process. The task of education as a cultural mission must be able to carry out several functions. Namely cultural inheritanc, helping individuals choose social roles and teaching them to perform these roles. integrating various individual identities into a broader artistic scope, and become a source of social innovation (M. Windu Antara Kesiman and K. Agustini 2012; T. T. H. Pham and P. Renshaw 2015; P.

Puspitasari and DS W, 2020). The inheritance of cultural values can be carried out by traditional learning, which always instills the conventional values of the community. It is concluded that local cultural character is learning that instills character values to produce active and inactive learning as a result of conceptualization in the learning process. Traditional classroom behavior does not support the active involvement of students in the learning process but focuses on the impact of direct context behavior and the teacher's role on students. Behaviorism theory has received criticism from cognitive proponents who believe that the involvement of students in the learning process is more meaningful in developing skills, experiences, and knowledge.

The values of local cultural characters include Love for God. The universe and its contents, responsibility, discipline, and independence, honesty, respect and courtesy, compassion and care, self-confidence, creativity, hard work, and never give up, justice and leadership, Kind and humility, Tolerance, love, peace, and unity.

Problem Solving Skill

Problem-solving ability is a learning process carried out by students. In gaining experience using the knowledge and skills they already have to apply to problem-solving that is not routine. The ability to solve problems requires a special skill and ability possessed by each student, which may differ between students in solving a problem (Ibrahim, et al (2017). Refers to the researcher's opinion so that it can be concluded that a process to obtain solutions to problems is carried out through four stages of problem-solving. Namely understanding the problem, determining the problem, solving the problem according to plan, and doing double-check against completion (D. Zhang (2017); N. Diana, D. Suryadi, and J. A. Dahlan, (2020); S. Carreira and H. Jacinto (2019); A. Levav-Waynberg and R. Leikin (2012).

Problem-solving activities include; (1) Identifying sufficient data to solve the problem; (2) Creating a mathematical model of a problem and solving it; (3) Selecting and implementing strategies for solving math problems; (4) Interpret the results and check their accuracy; (5) Apply mathematics meaningfully.

Kirley (2003) identifies a primary sequence of three cognitive activities in the problem-solving process: 1). Represent the problem. In the form of recalling context, corresponding knowledge identifies the objectives and initial conditions relevant to the problem at hand. 2). Looking for a solution. Includes refining goals and developing a plan of action in achieving goals. 3). Implementing a solution includes executing the action plan and evaluating the results.

Polya (1973: VIII) suggests the process at each problem-solving step through the following questions: Understanding the problem (understanding the problem), including 1). what is unknown? 2). what data is provided? 3). Are the conditions provided sufficient to seek what is being asked ?. This step involves several aspects, including the following: 1). Which theory can be used in this problem? 2). Notice what is being asked. Alternatively, try to think about a familiar problem with the same question. 3). Get the results and methods used here ?. 4). Have all the data and conditions been used? 5). Have you taken into account the essential ideas that will be used in this question?

Perform calculations (carrying out the plan). This step emphasizes the execution of the complete plan. The procedures taken are 1). This is checking each step whether it is correct or not? 2). How to prove that the selected step is correct ?. Review the process and results (looking back) at the end. Polya emphasized how to check the correctness of the answer. The procedures that must be considered are 1). Can you check the objections? 2). Can the answer be sought in any other way?.

Geometry

Geometry is a branch of mathematics that has an important position to study. Besides that, Geometry also has a significant role in studying other branches of mathematics. For example, the concept of fractions can be concretized by the use of geometric shapes and shapes. Fractions are closely related to the idea of geometry, namely, as part of a whole. Furthermore, geometry provides a context that can make it easier to solve problems in other branches of mathematics, for example, the use of figures, diagrams, and coordinate systems.

Everyone in everyday life uses geometry. Scientists, architects, artists, engineers, and real estate developers are just a few examples of professions that regularly use geometry. In everyday life, geometry is used to design houses, gardens, or decorations (Van de Walle, 1990: 269).

Exploratory activities in geometry can develop problem-solving skills. Spatial reasoning in geometry is a necessary form of problem-solving. Problem-solving is an essential reason for studying mathematics. Thus, it can be realized that learning geometry is essential. Students from elementary school to college are expected to study geometry and understand geometric ideas well. Geometry ideas have been known and familiar to students since before they entered school. Students can recognize geometric objects in everyday life in childhood, for example, lines, angles, planes, and spaces. Therefore, geometry has a greater chance of being understood by students than other branches of mathematics.

In the United States, only half of the existing students take formal geometry lessons (Bobango, 1993: 147). This indicates that students are reluctant to study geometry. Of the students who study formal geometry, only about 34% of these students can prove theories and do exercises deductively (Senk, 1989: 318). In addition, the achievement of all students in problems related to geometry and measurement is still low (Bobango, 1993: 147). Furthermore, Hoffer stated that both students in America and the Soviet Union had difficulty learning geometry (Kho, 1996: 4).

METHOD

The experimental design used in this study was the randomized pretest-posttest control group design. In this study, two groups will be involved. The first group was the group that received the Science, Technology, Engineering, and Mathematics (STEM) learning treatment (X1) as the experimental group. While the second group, namely the group that received conventional learning (X2) as the control group. To know the increase in understanding of geometry and problem solving, N-gain data is used. The results of

these measurements were analyzed and compared with the statistical tests used. The research design can be seen in the table as follows:

Table 1

Measurement of the ability to solve geometric problems using the pre-test and post-test

Class	Pretest	Treatment	Posttest
E	0 ₁	X ₁	0 ₂
K	0 ₃	X ₂	0 ₄

Information:

E: Samples of the experimental group that were taken randomly

K: Samples of the control group who were taken randomly

01: Experimental group data given a pre-test

02: Experimental group data given a post-test

03: Control group data given the pre-test

04: Control group data given post-test

Instrument

Geometry problem-solving ability tests are scattered on each sub-concept and indicator tested in the form of essay tests. Before use, the test instrument will be tested to obtain data about difficulty, difference power, validity test, reliability test.

Data Collection

The data collection of this research was obtained from the test results of the ability to solve geometric problems in essays scattered on each sub-concept and indicator testing. Before use, the test instrument will be tested to obtain data about difficulty, difference power, validity test, reliability test.

Data Analysis

The homogeneous test was used to determine the variance of the experimental and control groups. The homogeneous test uses the Fisher method with the following test procedure (Walpole, et al, 2012). The test statistic used if the data is normally distributed and homogeneous is the pooled variance t-test with a significance level of 5% (Budiyono, 2009).

Research Hypothesis Formulation:

H₀: The Science, Technology, Engineering, and Mathematics (STEM) learning model based on Bima's local cultural not affect the problem-solving ability.

H₁: The Science, Technology, Engineering, and Mathematics (STEM) learning model based on Bima's local cultural affect the problem-solving ability

FINDINGS

The Results of Geometry Problem Solving Ability

The results of the geometric problem-solving ability of the experimental group using Science, Technology, Engineering, and Mathematics (STEM) learning model based on

Bim's local cultural and the control group using ordinary learning in each pre-test and post-test, in general, can be shown in Table below.

Table 2

Profiles of geometry problem solving ability in experiment group and control group for each pre-test and post-test

Group Type	Experiment					Control				
	SMI	X_{maks}	X_{min}	\bar{X}	S	SMI	X_{maks}	X_{min}	\bar{X}	S
Post test	30	29	19	23.80 (79.33%)	2.89	30	24	6	17.72 (59.07%)	3.66
Pre-test	30	20	6	13.04 (43.47%)	4.44	30	23	6	13.48 (44.93%)	5.13

Based on the table above shows that the ideal maximum score is 30. In the experimental group, the highest score obtained during the pre-test was 20, the lowest score was 6, the mean score was 13.04 or 43.47% of the ideal score, and deviation standard of 4.44, while at the post-test, the highest score increased to 29, the lowest score achieved increased to 15, the mean score increased to 23.80 or 79.33% of the ideal score, and the standard deviation of 2.89. While in the control group, the highest score obtained during the pre-test was 23, the lowest score was 6, the mean score was 13.48 or 44.93% of the ideal score, and the standard deviation was 5.13 at the post-test. The highest score increased to 24. The lowest score achieved remained at 6, and the mean score increased to 17.72 or 59.07% of the ideal score and the standard deviation of 3.66. Visually, the geometric problem-solving abilities of high school students can also be shown by the diagram in Figure below this.

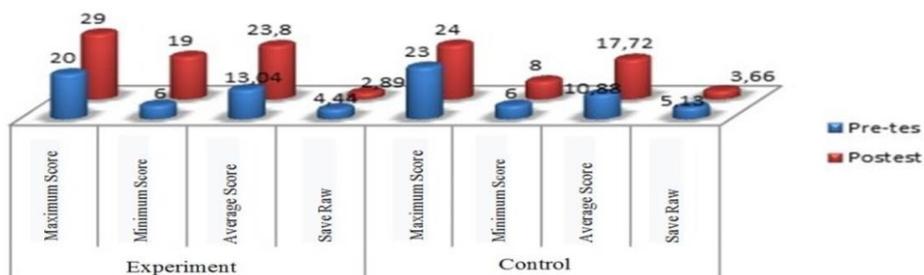


Figure 2

Profile diagram of geometry problem solving ability experiment and control group

The diagram in Figure above shows that the geometry problem-solving abilities of high school students using Science, Technology, Engineering, and Mathematics (STEM) learning are higher than ordinary learning.

Then the geometry problem-solving abilities of each problem-solving stage can be shown in Table below.

Table 4
Profile of geometry problem solving ability in experiment group and control group for each problem-solving stage

Type of Test	Step Solution to problem	Experiment			Control		
		Score Max	Average	Category	Score Max	Average	Category
Pre Test	Understanding the Problem	2	1.23	Enough	2	1.31	Enough
	Develop a plan	4	1.00	Low	4	1.03	Low
	Carry out the Plan	2	1.44	High	2	1.48	High
	Check again	4	0.73	Enough	4	0.73	Enough
Post Test	Understanding the Problem	2	2.00	High	2	1.76	High
	Develop a plan	4	2.39	Enough	4	1.47	Enough
	Carry out the Plan	2	1.95	High	2	1.72	High
	Check again	4	1.60	High	4	1.01	Enough

The table above shows the problem-solving ability of the experimental group and the control group at the stage of understanding the problem at the pretest was classified sufficient. In contrast, at the post-test, it was classified as high. The problem-solving ability at the planning stage for the experimental and control groups was low at the pretest. In contrast, at the post-test, the problem-solving abilities at the planning stage, both the experimental and control groups, were classified as sufficient. Then the problem-solving ability at the stage of implementing the plan achieved by the experimental group and the control group during the pretest and post-test were both classified as high. Furthermore, the problem-solving ability at the rechecking stage, at the time of the pretest, both the experimental group and the control group were both classified as sufficient, while the post-test for the experimental group was classified as high, but for the control group, it was still classified as sufficient.

Table 5
Pre-test data homogeneity test results & gain on geometry problem solving ability in each experiment group and control group

Aspect Ability	Pre test		Gain	
	Experiment	Control	Experiment	Control
N	25	25	25	25
Varians (S^2)	19.707	26.343	0.029	0.030
$F_{count} = \frac{S_{besar}^2}{S_{kecil}^2}$	1.337		1.034	
$F_{table} = F_{0.05(24,24)}$	1.98		1.98	
Conclusion	Homogeneous		Homogeneous	

Based on Table 5 above shows the F test value (F_{obs}) for all observed data is less than the F-table value ($F_{0.05, 24, 24}$) or $F_{obs} < F_{0.05, 24, 24}$ so that the eight observed data are typically distributed, namely the data: 1) pre-test data for the control group geometry problem solving, 2) post-test data for the control group geometry problem solving 3), 4) N-gain data for the experimental group geometry problem solving, 5) N-gain data solving control group geometry.

Based on the description above, it can be concluded that all data are typically distributed and homogeneous so that the eight data can be used inferential statistics (t-test) in testing hypothesis I and the F test in testing the balance of initial abilities. The t-test used was the combined variance test or the pooled variance t-test. While the F test used is the F test (one-factor ANOVA test).

Initial Ability Balance Test Results

Information related to the results of the balance test of the initial ability to the ability to understand geometry and the ability to solve geometric problems can be seen in the Anova Table 6 below.

Table 6
Anova table of balance test results of initial ability in geometry problem solving

Source of Variance	SS	V	MS	F _{obs}	F _{0,05 (1, 48)}	Decision	Conclusion
Treatmen (Tr)	2.420	1	2.420	0.105	4.04	Refuse t H ₀	Balanced
Error	1105.20	48	23.025				
Total	51107.62	49					

Table 6 above also shows that the value of Fcount is less than Ftable or Fobs = 0.012 < F0.05 (1.48) = 4.04 so that H₀ is rejected. This means that the average initial ability to solve geometric problems in the two groups is balanced. In other words, before being given treatment using Science, Technology, Engineering, and Mathematics (STEM) learning based on Bima's local cultural or using ordinary learning, the two samples had the same geometric problem solving abilities.

Hypothesis Test Results

Information related to the results of research hypothesis testing can be shown in Table 7 below.

Table 7
Recapitulation of research hypothesis test results

Hipotesis ke	N	V	T _{count (tobs)}	t _{table (t0,05,48)}	Decision
I	25	42	8.151	2.013	Refuse H ₀

Based on Table 4.8 above, it shows that the value of t count is more than t table or tobs = 8.150 > t0.05, 48 = 2.013 so that H₀ is rejected. So, it can be concluded that the Science, Technology, Engineering, and Mathematics (STEM) learning model based on Bima's local cultural affect the problem-solving ability.

DISCUSSION

Before the learning process took place, the two groups departed from their initial abilities, which did not significantly differ. Can be seen from the results of the data analysis of the prerequisite material test scores that statistically, the mean scores of the prerequisite material for the control and experimental groups are the same.

Based on the results of data analysis, both testing of statistical hypotheses with t-test with a significant level of 0.05 and data analysis for each item of student answers, it turns out that the geometric problem-solving abilities of students who learn with STEM learning are better than students who learn with ordinary learning.

The ability of students to solve geometric problems in the experimental class showed a genuine difference with the abilities possessed by students in the control class. STEM learning based on the local cultural character of Bima can activate students in the learning process at each student's initial ability level. STEM learning that involves daily activities with cultural values is more able to give meaning to students. It is indicated by better student activity in the experimental class than in the control class. In line with the results of this study, Cahyaningrum & Sukestiyarno (2016) states that there is a positive influence on problem-solving skills and the character of love for local culture on problem-solving abilities. It was concluded that the character of the local culture of students had a positive influence on student work in solving math problems.

Based on the results of this study, compared to ordinary learning, STEM learning shows a significant role in improving students' geometry problem-solving abilities. Can be understood because students in the experimental group who get STEM learning are accustomed to solving story problems. The questions given should trigger students to use their abilities and skills to their full potential. It means that the questions presented must encourage students to seek and use an approach from the perspective of solving. Exploring various strategies, providing opportunities to study the steps that have been, are being, and will be carried out, and improving the way that has been done. Giving questions that are the story in nature can develop the ability to produce various answers or solutions in solving problems. According to Polya (2004) there are four stages in solving the problem, namely: (1) understanding the problem: in this activity formulating: what is known, what is asked, is the information sufficient, conditions (conditions) what needs to be fulfilled, restate the original problem in a more operational (solvable) way. (2) the activities carried out in this step are trying to find or recall problems that have similarities to the properties to be solved, look for patterns or rules, compile a resolution procedure. (3) carry out the plan: the activity in this step is to carry out the procedure made in the previous step for completion. (4) rechecking procedures and completion results: the activities at this stage are to analyze and evaluate whether the procedures applied and the results obtained are correct, are there other procedures that are more effective, whether the procedures that have been created can be used to solve similar problems, or whether generalization procedures can be made.

CONCLUSION

Based on the results of data analysis and findings obtained in the field while carrying out research using the "Science, Technology, Engineering, and Mathematics (STEM)" learning model, the following conclusions are obtained: Increasing the geometric problem-solving abilities of high school students who learn through Science, Technology, Engineering, and Mathematics (STEM) is better than students who get regular learning. The improvement in problem-solving of students studying with Science, Technology, Engineering, and Mathematics (STEM) is moderate.

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