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FMSLOGO AND SOLVING GEOMETRY PROBLEMS USING THE FMSLOGO SOFTWARE PACKAGE

Original scientific paper

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ABSTRACT

This paper presents stereometry (prism) using the software "FMSLogo", as well as its application and implementation in mathematics teaching. The introductory section describes how to approach mathematical problems according to George Polya. The following describes the creation, installation and use of the "FMSLog" software. At the very end of the paper are the research settings and its results, which through the empirical model shows the current state of affairs and therefore provides recommendations for its improvement.

Keywords: *FMSLogo, Logo, geometry, planimetry, stereometry, prism*

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INTRODUCTION

Contemporary teaching approaches aim to put theoretical knowledge into practice. Interactive classroom content uses computer programs and equipment to visualize the process. One of the most important goals of studying mathematics is to teach students to think, that is, to enable them to solve problems in their future lives. In his work, the mathematician George Polya talks about solving mathematical problems in four steps: a problem, making a plan, executing a plan, and looking back. (Ovčar S., 78.)Every mathematical problem needs to be identified, a plan for its solution must be made, it is examined if that plan of solution is feasible, if so, and ultimately a solution to the problem. Interactive approach solving is applied in this model.

Various mathematical software is intended for innovative, interactive and dynamic teaching of different areas of mathematics. FMS Logo is a programming language that has an educational purpose. It is designed for constructivist learning by Daniel G. Bobrow, Wally Feurzeig and Seymour Papert. He is best known for his "turtle graphics". The logo can be used to teach the concept of computer science. Its features are: modularity, scalability, interactivity and flexibility. This programming language is characterized by the use of the Turtle Logo, which moves the trail. Logo is a dynamic geometric system. Allows you to draw geometric shapes according to the given dimensions and coordinates. The logo was developed to help children develop logical thinking and to more easily perceive the shapes around them.

This programming language also provides opportunities for cooperative learning, which is a good choice of modes for many mathematical fields. The primary role of the teacher is not to teach, explain or otherwise transfer knowledge, but to create situations that will allow students to think and reason logically. This programming language allows you to visualize math, interactive distance lessons, and various applications of math. Geometry has always been a favorite mathematical branch because of its vividness. The geometric body, ie its model, can be seen, touched, made, presented, therefore fully experienced. [2]

A 6-7 year old child is best placed in the subject world, so it is reasonable to believe that mathematics classes should begin with geometric contents - shapes in space or geometric bodies. Almost all methodologists point out that the development of logical thinking is the most important in teaching mathematics. Logical thinking means the application of formal logical operations in the process of thinking, arranging, and systematizing the material studied using the laws of logic. "Technology development has led to advancements in many fields, so technology was expected to have a major impact on teaching. Despite the many benefits of using technology in mathematics education, the process of integrating technology in classrooms has proven to be slow and complex. "(Hohenwarter, Hohenwarter, Kreis & Lavicza, 2008).

The name of this programming language is derived from the Greek word "logos" which means thought in translation. The first version of this program was made back in 1967 at the American University **MIT** (Massachusetts Institute of Technology). One of the creators of this programming language was the famous mathematician Seymour Papert.

Programming Language Logo has been developing and improving. There are different versions of this programming language today, and many of them are free to use. This programming language can be used in mathematics, biology, physics, languages, music, robotics and in science. The logo enables the creation of simulations and multimedia presentations. This programming language does not require much knowledge at first, and there are many options. Because of its simplicity, it is easy for beginners to use, while providing more sophisticated research and projects for experienced users.

Geometry is a scientific discipline that dates back to ancient civilization. The very word geometry dates back to ancient times when it meant measuring the earth or measuring it. Ever since the ancient civilizations of Sumerians, Egyptians, Babylonians and other nations, people have had knowledge of angles, triangles, quadrilaterals...

[2] Defining initial geometric terms: http://marul.ffst.hr/~logika/content15.htm

Geometry developed as an inductive science, which, with the help of empirics and different senses, was upgraded, that is, from individual cognitions some general ones were derived. Ancient Greeks in the 6th c. have begun to study geometry in greater detail.

All knowledge acquired from other peoples is systematized and verified ie proved. The deductive way of proving geometric claims came first from the philosopher Tales. These Tales writings do not exist, which is why it cannot be claimed that he was able to prove some of his claims. According to his philosophical claims, geometric objects are identified with physical ones, and physical motions are used to prove geometric claims. The ancient Greek philosopher and mathematician Pythagoras used to prove geometric claims. His great contribution is to the study of geometry and to the theory of large numbers. Pythagoras' most famous theorem is: "The area of a square above the hypotenuse of a right triangle equals the sum of the areas of a square above the catheters." (Dadić Ž., 32.)

Euclid was most important for geometry in his work Elements. This section describes the space we live in. The "elements" consist of 13 books, where the first 6 refer to planimetry, the next 4 to geometric number theory, and the last 3 to stereometry. These books are usually accompanied by 2 shorter book monographs. These books are considered by many to be extensions of the "Elements". Throughout history it is revealed that the first book was written by a pupil of Euclid the Hipsikle of Alexandria, and the second by an unknown author. Euclid used a deductive way of proving and arguing geometry. In order to use the deductive method, it is necessary to use logical thinking and perception. (Dadić Ž., 69.)

Planimetry is part of elementary geometry that studies the properties of geometric figures in the Euclidean plane. The basic planimetric elements are sets of points, direction, length, angle, circle and circle. They are more complex than the basic elements; geometric figures and geometricalshapes.

Stereometry was also used for this research, so something will be said briefly. Stereometry is a part of geometry that deals with the examination of geometric bodies and shapes, which are located in space. Elementary school students learn stereometry in the eighth grade of eight-year school or in the ninth grade of nine-year-olds. The first topic addressed is the relation of direction and plane, the relationship of two directions, and the relationship of two planes. The study of directions and planes is performed using the cube and square model, the relationship of the edges and the relationship of the sides on the cube and square model are studied. These are basic lessons in space geometry. This whole is completed by processing by processing the orthogonal projection of a point on the plane and the distance of the point from the plane. After this area, students begin to study geometric bodies and their properties. Teachers use models of geometric bodies to aid learning. A geometric body is a part of a space bounded by surfaces, and consists of points that perish in the same plane.

In everyday life we come across many objects that have some geometric shape. Because of this, students learn to distinguish geometric bodies, their surfaces and edges using models. The bodies being treated are prisms (regular upright prisms), pyramids (upright pyramids), upright roller, cone and ball. The numerical magnitudes explain the computation of the area and volume of each geometric body. It is difficult for students to present a 3D representation of geometric bodies, which is why most teachers and professors in this field reduce students to calculating unknown sizes using formulas, which is not quite correct for such a lesson. Each student has the creativity that should be used to learn the properties of geometric bodies through practical work, such as making models of prisms, pyramids, rollers, or balls, or to calculate area or volume using a model made. In order to be able to apply the practical work in these lessons, it is necessary for students to have the foreknowledge of the geometric figures they need to create the body networks.

One practical example: based on a four-sided prism model, the area needs to be calculated - students must first disassemble a geometric body made of paper and plastic. Once disassembled, they will receive a prism net.

They will then determine what its sides are and what its base is. After these established facts, they will be able to measure the required lengths and solve the task.

By logical inference after the model is made, and then the disassembled model is finished, we can say that the surface of the geometric body is the surface of the mesh of that body. In order to make it easier for students to understand what the volume of a body is, it is easiest to explain it by an example of a cube, for example, during the introductory lesson, students can be shown a model of a cube with a length of 1 cm, 1 dm and 1 m. given the length of the edge of the cube.

In my research, I worked with students on the part of stereometry, a chapter called prisms. For the purposes of working with the experimental group, IT equipment with the software "FMSLogo" was used. In the introductory lesson it was necessary to repeat the geometric figures:

- Triangle - equilateral, versatile, isosceles, pointed, rectangular and obtuse
- square - square, rectangle, parallelogram, rhombus
- polygon - regular pentagon, hexagon, n-triangle
- circle and circle

ANALYSIS AND INTERPRETATION OF RESEARCH

Before starting the research, it was necessary to divide the students into two groups. Since this is an experimental research, one group treated the lessons with the help of IT equipment, and with the other group in a classic way with the help of geometric accessories. The experimental group had 33 students, of which there were 16 girls and 17 boys. The control group had 34 students, of which there were 16 girls and 18 boys. Initial testing was performed with both groups on the first lesson to determine if the groups were uniform. It was important that in both groups the level of knowledge was approximate.

Table 1. Mann-Whitney Test

Ranks

	Group	N	Mean Rank	Sum of Ranks
sum of initial	Experimental	33	37.61	1241.00
	Control	34	30.50	1037.00
	Total	67		

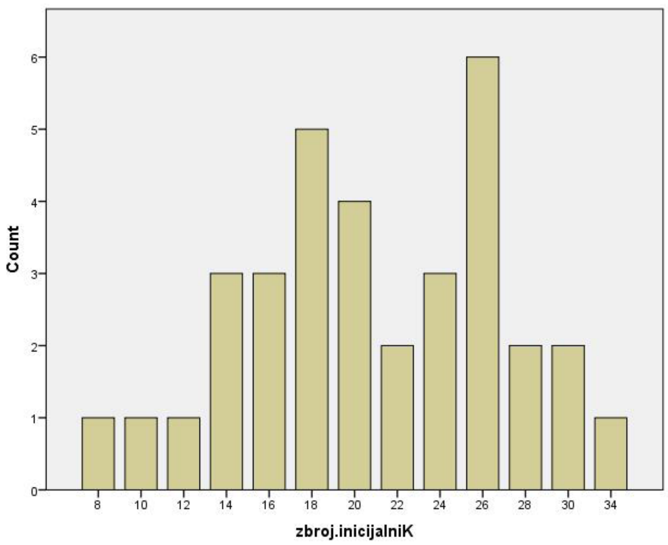
Test Statistics[a]

	sum of initial
Mann-Whitney U	442.000
Wilcoxon W	1037.000
Z	-1.497
Asymp. Sig. (2-tailed)	.134

a. Grouping Variable: Group

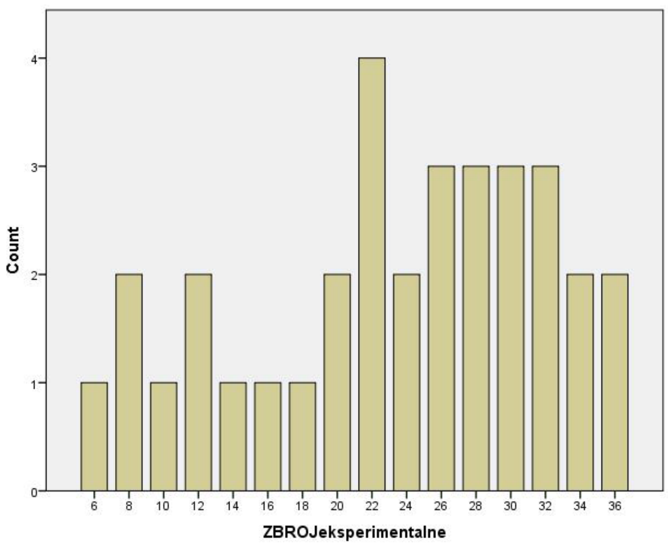
The first table (Ranks) shows the respondents by groups. The second table (Test Statistics) has a Mann-Whitney U test value of 442.000 and a significance value of .134. Based on these results, it can be concluded that there is no statistically significant difference between the groups in the initial testing.

First sub-hypothesis: It is assumed that students have a basic background in geometry (ie they know how to distinguish geometric shapes)



Graph 1. Initial control group teste

From Graph 1 we see that one student scored the lowest number of points (8 points) and one student scored the highest number of points (34 points). The same number of students won the lowest and highest points. Other students had average knowledge. The control group scored 712 points in total, averaging 20.94 points per student.

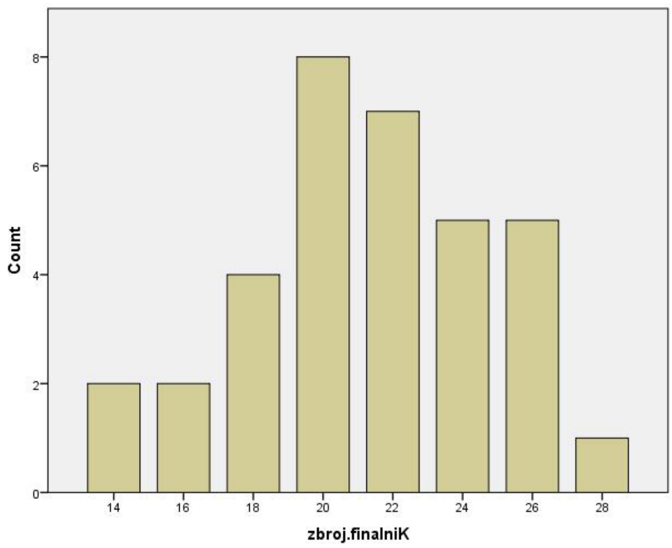


Graph 2. Initial test of the experimental group

From Graph 2 we see that one student scored the lowest number of points (6 points) and two students scored the highest number of points (36 points). The difference between the number of students who had the lowest score and the highest score is one. Other students had average knowledge. The experimental group scored a total of 768 points, averaging 23.27 points per student.

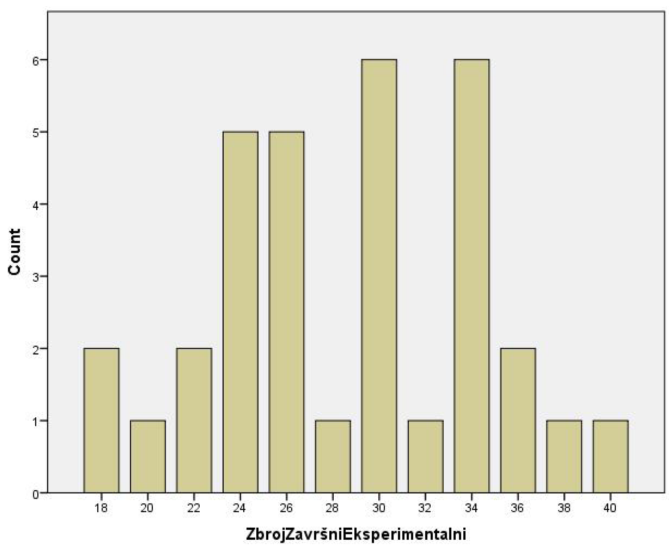
From the previous two graphs we can see that the students have a satisfactory level of knowledge, ie on average, each student earns half a point out of the total number.

Second sub-hypothesis: It is assumed that the application of FMS Logo software results in better results on geometric units.



Graph 3. Final control group test

From Graph 3. we see that two students scored the lowest number of points (14 points) and one student scored the highest number of points (28 points). The difference between the number of students who had the lowest score and the highest score is one. Other students had average knowledge. The control group scored 724 points in total, averaging 21.29 points per student.



Graph 4. Final test of the experimental group

From Graph 4. we see that two students scored the lowest score (18 points) and one student scored the highest score (40 points). The difference between the number of students who had the lowest score and the highest score is one. Other students had average knowledge.

The control group scored 944 points in total, averaging 28.61 points per student.

We can see from the graphs that the experimental group had a total of more points than the control group.

Table 2. Mann-Whitney Test

Ranks

	Group	N	Mean Rank	Sum of Ranks
sum.initial	Experimental	33	37,61	1241,00
	Control	34	30,50	1037,00
	Total	67		
sum.total	Experimental	33	45,92	1515,50
	Control	34	22,43	762,50
	Total	67		

Test Statistics[a]

	sum.initial	sum.total
Mann-Whitney U	442,000	167,500
Wilcoxon W	1037,000	762,500
Z	-1,497	-4,969
Asymp. Sig. (2-tailed)	,134	,000

a. Grouping Variable: Group

The first table (Ranks) shows the respondents by groups. In the second table (Test Statistics) is the value of the Mann-Whitney U test, for the final test, which is 167,500 and its significance is 0.000. Based on these results, it can be concluded that there is a statistically significant difference between the groups in the final examination.

Table 3. Results of descriptive and inferential statistics for the experimental and control group

Claim (question)			Experimental Group				Control group			
			M	SD	t-test	*p*	M	SD	t-test	*p*
1.	TASK 1	I	2.36	1.454	.058	.747	2.12	1.552	.049	.781
		F	2.73	1.206			2.29	1.115		
2.	TASK 2	I	2.36	1.454	.418	.015	2.18	1.242	-	.602
		F	2.85	1.121			2.76	1.208	.093	
3.	TASK 3	I	2.36	1.617	.382	.028	1.65	1.252	.118	.507
		F	3.15	1.121			1.65	.774		
4.	TASK 4	I	2.30	1.591	.462	.007	1.41	1.048	.459	.006
		F	2.61	1.273			1.35	.950		
5.	TASK 5	I	2.36	1.537	.549	.001	1.35	1.368	.234	.183
		F	2.73	1.306			1.41	1.048		
6.	TASK 6	I	2.24	1.393	.578	.000	2.18	1.242	-	.828
		F	2.67	1.190			2.29	1.115	.039	
7.	TASK 7	I	2.73	1.398	.380	.029	2.65	1.454	.243	.166
		F	3.21	1.111			2.41	1.282		
8.	TASK 8	I	2.18	1.685	.472	.006	2.76	1.394	.188	.288
		F	3.03	1.015			2.41	1.076		
9.	TASK 9	I	2.24	1.562	.374	.032	2.35	1.515	.291	.095
		F	3.15	1.004			2.24	1.182		
10.	TASK 10	I	2.12	1.495	.537	.001	2.29	1.643	.103	.563
		F	2.48	1.326			2.47	1.308		
	THE SUM OF ALL QUESTIONS	I	23.27	8.658	.891	.000	20.94	6.154	.437	.010
	THE SUM OF ALL CLAIMS	F	28.61	5.733			21.29	3.546		

Experimental group:

A value of t =.058 as well as its significance of .747 above the cut-off value of .05 indicates that there is no statistically significant difference between initial and final testing for the first task.

A value of t = .418 as well as its significance of .015 which is below the cut-off value of .05 indicates that there is a statistically significant difference between initial and final testing for the second task.

A value of t = .382 as well as its significance of .028 which is below the cutoff value of .05 indicates that there is a statistically significant difference between initial and final testing for the third task.

A value of t = .462 as well as its significance of .007 which is below the cut-off value of 0.05 indicates that there is a statistically significant difference between initial and final testing for the fourth task.
A value of t = .549 as well as its significance of .001 below the cut-off value of .05 indicates that there is a statistically significant difference between initial and final testing for the fifth task.
The value of t = .578 as well as its significance of .000 below the threshold .05 indicates that there is a statistically significant difference between initial and final testing for the sixth task.
A value of t = .380 as well as its significance of .029 which is below the cut-off value of 0.05 indicates that there is a statistically significant difference between initial and final testing for the seventh task.
A value of t = .472 as well as its significance of .006 which is below the .05 threshold indicates that there is a statistically significant difference between initial and final testing for the eighth task.
A value of t = .374 and a significance of .032 below the cut-off value of 0.05 indicates that there is a statistically significant difference between initial and final testing for the ninth task.
A value of t = .537 and a significance of .001 below the cut-off value of .05 indicates that there is a statistically significant difference between initial and final testing for the tenth task.

Control group:

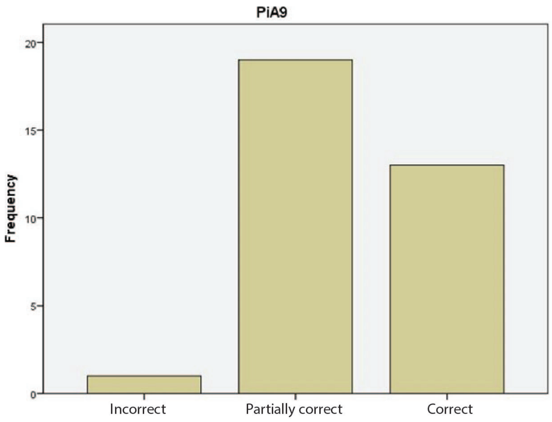
A value of t = .049 as well as its significance of .781 above the cutoff value of .05 indicates that there is no statistically significant difference between initial and final testing for the first task.
A value of t = -.093 as well as its significance of .602 above the cut-off value of .05 indicates that there is no statistically significant difference between initial and final testing for the second task.
A value of t = .118 as well as its significance of .507 above the cut-off value of .05 indicates that there is no statistically significant difference between initial and final testing for the third task.
A value of t = .459 as well as its significance of .006 below the cut-off value of .05 indicates that there is a statistically significant difference between initial and final testing for the fourth task.
A value of t = .234 as well as its significance of .183 above the cut-off value of .05 indicates that there is no statistically significant difference between initial and final testing for the fifth task.
A value of t = -.039 as well as its significance of .828 above the cut-off value of .05 indicates that there is no statistically significant difference between initial and final testing for the sixth task.
A value of t = .243 as well as its significance of .166 above the cut-off value of .05 indicates that there is no statistically significant difference between initial and final testing for the seventh task.
A value of t = .188 and its significance of .288 above the cut-off value of .05 indicates that there is no statistically significant difference between initial and final testing for the eighth task.
A value of t = .291 as well as its significance of .095 above the cut-off value of .05 indicates that there is no statistically significant difference between initial and final testing for the ninth task.
A value of t = .103 as well as its significance of .563 above the cut-off value of .05 indicates that there is no statistically significant difference between initial and final testing for the tenth task.
In the second and sixth tasks, the value of the t-test is negative (- sign), and the advantage is on the final testing side.
Looking at Tables 2 and 3 we can conclude that there is a statistically significant difference between the control and experimental groups. The experimental group performed better than the control group. This proves the second sub-hypothesis.

Third subhypothesis: It is assumed that the application of FMS Logo software on geometric units creates student satisfaction.
Question: This mode is appropriate for a better understanding of mathematics

Table 4.Results of the ninth question

PiA9

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Incorrectly	1	3.0	3.0	3.0
	Partlly correct	19	57.6	57.6	60.6
	Correct	13	39.4	39.4	100.0
	Total	33	100.0	100.0	



Graph 5.Results of the ninth question

By examining, 19 students out of 33 partially agree with this statement, while 13 students completely agree with it. From this I can conclude that the use of IT equipment has a positive effect on the course of the lesson, and the children better understand the material.

Sub-hypothesis 4: It is assumed that the application of FMS Who software creates a high degree of satisfaction.

Question: The way the material is interpreted is interesting and motivating

Table 5. Results of 2.claims / questions

PiA2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Incorrectly	7	21.2	21.2	21.2
	Partlly correct	10	30.3	30.3	51.5
	Correct	16	48.5	48.5	100.0
	Total	33	100.0	100.0	

Of the 33 respondents, 7 (21.2%) considered the statement to be inaccurate, 10 (30.3%) believed the statement to be partially true and 16 (48.5%) that the statement of completeness was true. From this we can see that most of the respondents think that this way of interpreting the material is interesting and motivating.

Question: Using the FMS Logo software allows you to better understand the material

Table 6. Results of 4.claims

PiA4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Incorrectly	8	24.2	24.2	24.2
	Partly correct	9	27.3	27.3	51.5
	Correct	16	48.5	48.5	100.0
	Total	33	100.0	100.0	

Of the 33 respondents, 8 (24.2%) thought the statement to be inaccurate, 9 (27.3%) that the statement was partially true and 16 (48.5%) that the statement of completeness was true. From this we can see that the majority of respondents think that the use of "FMSLog" software enables a better understanding of the material.

Question: Presenting material through the "FMS Logo" software is interesting, and independent use is possible and easy

Table 7. Results of 5th claim

PiA5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Incorrectly	10	30.3	30.3	30.3
	Partlly correct	14	42.4	42.4	72.7
	Correct	9	27.3	27.3	100.0
	Total	33	100.0	100.0	

Of the 33 respondents, 10 (30.3%) thought the statement to be inaccurate, 14 (42.4%) that the statement was partially true and 9 (27.3%) that the statement was completely true. From this we can see that the majority of respondents partly think that the use of the "FMSLogo" software is interesting and easy to use independently.

Question: Students are mostly actively involved in work through conversation, task design, hands-on work, and student presentations

Table 8. Results of claim 7

PiA7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Incorrectly	5	15.2	15.2	15.2
	Partlly correct	22	66.7	66.7	81.8
	Correct	6	18.2	18.2	100.0
	Total	33	100.0	100.0	

Of the 33 respondents, 5 (15.2%) thought the statement to be inaccurate, 22 (66.7%) said the statement to be partially true and 6 (18.2%) that the statement was completely true. From this we can see that the majority of students are active on the class and that they independently approach all the tasks in the work.

Based on the results from the above tables, I can conclude that the use of "FMSLOG" software creates a high degree of student satisfaction.

Fifth sub-hypothesis: It is assumed that there is no difference in degree of satisfaction with respect to gender

Table 9. Mann- Whitney test

Ranks

	Group	N	Mean Rank	Sum of Ranks
sum	Experimental	16	17,72	283,50
	Control	17	16,32	277,50
	Total	33		

Test Statistics[a]

	sum
Mann-Whitney U	124.500
Wilcoxon W	277.500
Z	-.420
Asymp. Sig. (2-tailed)	.674
Exact Sig. [2*(1-tailed Sig.)]	.683[b]

a. Grouping Variable: gender

b. Not corrected for ties.

The first table gives us information about respondents by gender. The Mann-Whitney U value of the test is 124.500 and has a significance of .683, on the basis of which we can conclude that there is no difference in the degree of satisfaction in boys and girls when using the software "FMALoga" in mathematics lessons. This proves the fifth sub-hypothesis.

Having proved all the supporting hypotheses, we can conclude that the use of FMSLoga has had a positive effect on students.

CONCLUSION

In this paper, we investigated the impact of the application of "FMSLogo" software during the teaching of stereometry material. The research began with the initial testing, which I wanted to check on the pre-knowledge of ninth grade students. It was important for the research setting that both groups have a uniform background. After the initial test, the control group was taught the material in stereometry in the standard way, while the experimental group used the software "FMSLogo" when teaching. After completion of the experiment, a retest was performed, both groups performing the same final test. The experimental group also did a survey to show if students were satisfied with the use of FMSLoga software in math classes. After analyzing and interpreting the results of the testing and the survey, we have come to the conclusion that the application of the "FMSLog" in the classes where stereometry is taught has a positive impact on the students. Students are more motivated to work, achieve better results, the atmosphere during the class is relaxed, students are more active during the class.

This kind of work of teachers and professors requires that he / she be educated in the use of computer equipment and educational software while teaching. I think that math teachers should be educated on not only the FMSLogo software but also some others that would help students to understand the math material more easily. In addition to education, teachers need to be equipped with schools, not all schools are equipped with a sufficient number of projectors and computers.

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