

Original paper

LEARNING BY SOLVING THE PROBLEMS IN THE TEACHING OF MATHEMATICS

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Abstract

To determine and present as much in our school of practice in the teaching of maths applied learning by solving problems, what are its strengths and what the respondents in order to propose the introduction of this system of instruction in other curricular subjects. The sample of respondents is a fixed 60 pupils of the first grade Mixed secondary school Živinice and 110 teachers (32 teachers of primary school and high school teachers, 78). By learning through problem-solving in teaching, student engage your personal knowledge and experience. Of the methods in this paper were used: the method of theoretical analysis and servej research methods. The results of the research show that the attitudes of students and teachers on the use of learning by solving the problems in the teaching of mathematics, positive and that this system of learning and should be used in the teaching content of other subjects.

Keywords: *learning by solving the problems, teaching mathematics, benefits, personal knowledge, importance.*

Introduction

Modern schools increasingly requires a class that has a research character. The school is obliged to make students for independent learning, self-study, self-education, or for permanent education. Life in the modern age is full of problems who are looking for quick, efficient and rational resolution. Since learning by solving the problem develops creative (creative) the opinion of the students, and it is this system of learning is considered most effective and necessary in the school of the pres-

ent and the future. Today on education as an essential element in which it is seeking solutions to build a better and more humane society. For these reasons the problem-based learning and problem solving is important factor which gives education a strategic dignity. What is the reason of strong interest for most forms of learning such as learning by solving problems in which they develop significant quality process opinions such as “(the criticality, flexibility and creativity), and make a narrower educational effects (cooperation, self-reliance, persistence) and develop mathematical virtues (rationality, the reasons and generalization).” (Kadum, 2005:5) Effective learning is a requirement of the modern time. Since it is the present teaching not enough effective, and are looking for more efficient and more rational solution. It’s still (Ničković, 1966) suggested that the educational process release redundant content and non-performing, learning that the learning process is subjected to demands for a more rational by directing and management and that students eligible for independent opinion, self-learning and self-education. The method and example of rationalization of teaching and increase its efficiency is learning by solving the problem.

Research Methodology

The subject of the research was to determine the attitudes of students and lecturers about learning by solving the problems in the teaching of mathematics. We also wondered how in Bosnian schools are represented on learning by solving problems, what are the benefits of this learning, what are the limitations in its use and what subjects are proposed in order to enhance this learning

system. The theoretical significance of research is reflected in the possible application of the theoretical knowledge and experiences in the field of pedagogy, didactics and methodology of teaching of mathematics in the teaching practice.

This research in theoretical terms of contributions:

- The scientific basis of the educational work on the contents of mathematics,
- The creation of favorable conditions for the methodical-didactic work on the contents of mathematics,
- Rational, systemic, precise and effective work on the contents of mathematics,
- The affirmation of research, learning, and creative revealing work
- The new position of students, research, revealing, etc.

The practical importance of this research is great and for the Professor, because they will provide help on how to more effectively and more actively changing the current teaching practice, Professor empowers students for independent learning, for independent problem solving in math and other problems, eliminating template and rigidity in the acquisition of knowledge, raises the overall success of students, fosters research spirit. In the survey, we went from the assumption that learning by solving problems in math class often used system learning mathematical content because of its benefits, and that it should be used in teaching other subjects.

1. It is assumed that students often find it difficult or reluctant to learn the mathematical content,
2. It is alleged that learning by solving the problem often represented the system of learning in our schools,
3. It is considered that the advantages of learning through problem-solving in math class this huge,
4. Belief is that the respondents attitude to learning by solving problems and should be used in teaching other subjects.

The sample of respondents

The sample of respondents is a fixed 60 pupils of the first grade Mixed secondary school Živinice and 110 teachers (32 teachers and elementary school teachers, 78 teachers, middle school), a total of 170 subjects.

Research and results

One of the tasks of our study was to investigate and present what are the attitudes of students toward learning through problem-solving in math class. To determine the attitudes of students, we examined two of the students of the Department with which it is often practice the program of learning contents of teaching mathematics through problem solving.

They teach students of mathematics contents be happy or not?

Table 1. Gender of respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	39	65.0	65.0	65.0
	Female	21	21.7	21.7	100.0
	Total	60	100.0	100.0	

Table 2. The success of students in the teaching of mathematics

From the teaching of mathematics have a grade:					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	An excellent	25	25.9	25.9	25.9
	Very good	21	21.7	21.7	47.7
	nice one	9	15.0	15.0	91.7
	Sufficient	5	8.3	8.3	100.0
	Total	60	100.0	100.0	

Table 3. How students learn the content of the teaching of mathematics

Students of mathematics content are reluctant to learn					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	4	6.7	6.7	6.7
	I disagree	10	16.7	16.7	23.3
	I agree and I do not agree	36	60.0	60.0	51.8
	I agree	7	7.3	7.3	59.0
	Always agree	3	5.0	5.0	100.0
	Total	60	100.0	100.0	

Table No. 4 Intelligibility of the content of the teaching of mathematics

The contents of the teaching of mathematics difficult to understand					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	3	5.0	5.0	5.0
	I disagree	11	18.3	18.3	23.3
	I agree and I do not agree	31	32.1	32.1	46.6
	I agree	12	20.0	20.0	59.0
	Always agree	3	5.0	5.0	100.0
	Total	60	100.0	100.0	

Intelligibility of the content of the teaching of mathematics.

The value of the χ^2 amounts to 43.66. Cut-off value χ^2 at 5 degrees of freedom and the significance level is 0.05 (11.07) and at the level of materiality amounts to 0.01 (15.08). Given that the resulting value χ^2 significantly above the determined values on both levels of significance, we can safely

claim that they are the answers of the respondents, statistically significant, not random, or that students of mathematics content difficult to understand.

How the students remember math content

The resulting value of the arithmetic mean (M), 2.97 and standard deviation (δ) indicate 0.920 divided the opinions of respondents on this issue and

Table No. 5 How the students remember math content

The mathematical content is weak and hard to remember					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	4	6.7	6.7	6.7
	I disagree	10	16.7	16.7	23.3
	I agree and I do not agree	34	35.2	35.2	80.0
	I agree	8	13.3	13.3	93.3
	Always agree	4	6.7	6.7	100.0
	Total	60	100.0	100.0	

Table No. 6 How often do teachers organize learning by solving problems in math class

Professor at the math class is organising the learning of problem solving					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I disagree	3	5.0	5.0	5.0
	I agree and I do not agree	5	8.3	8.3	13.3
	I agree	45	46.6	46.6	88.3
	Always agree	7	7.3	7.3	100.0
	Total	60	100.0	100.0	

the high homogeneity of the answers. Calculate χ^2 costs 44.65. Given that the value was obtained χ^2 significantly above the determined values on both levels of materiality and 0.05 0.01, we can safely conclude that the answers of the respondents, statistically significant, and not random.

How often do teachers organize learning by solving problems in math class

The obtained χ^2 amounts to 80.52. Given that it is obtained a value significantly above the value χ^2 on the 4 degree of freedom and the significance level is 0.05 (9.488) and 0.01 (13.277) we can conclude that the answers of the respondents, statistically significant, and not random. In the teaching of mathematics is often represented by learning through problem-solving which is very good and desirable.

How is learning by solving the problem of efficient learning system

The arithmetic mean is $M = 3.42$, and the standard deviation $\delta = 972,365$, which indicates that most of the students aware of the effectiveness of learning by solving the problems in the teaching of mathematics. Obtained a value of χ^2 is 65.91.

Given that the resulting value is well above the determined values χ^2 at 5 degrees of freedom and the significance level is 0.05 (11.07) and 0.01 (15.08) we can conclude that the answers of the respondents, statistically significant, and not random. Respondents view problem solving in math class a lot more efficient learning system.

Learning by solving problems contributes to a better understanding

Arithmetic mean (M) amounts to 3.80 and indicates that a student's views on this issue are positive, and the standard deviation (δ) 0.988 indicates the strong variability of the results. The value of the χ^2 amounts to 59.16. Cut-off value χ^2 reading on 5 degrees of freedom and the significance level is 0.05 (11.07) and 0.01 (15.08). Given that the resulting χ^2 significantly above the value χ^2 the determined significance on both levels, and we can safely conclude that the answers of the respondents, statistically significant, and not random. The majority of respondents agreed that solving the problems of more efficient learning system from the traditional teaching.

Table No. 7 The efficiency of learning by solving problems in teaching

Problem solving in math class is a much more efficient system of learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	7	7.3	9.1	9.1
	I disagree	3	5.0	5.1	16.9
	I agree and I do not agree	10	16.7	16.9	33.9
	I agree	36	60.0	37.9	94.9
	Always agree	3	5.0	5.1	100.0
	Total	59	98.3	100.0	
Missing	System	1	1.7		
Total		60	100.0		

Table No. 8 Learning by solving problems contributes to a better understanding

Solving problems contributes to a better understanding					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	3	5.0	5.0	5.0
	I disagree	4	6.7	6.7	7.3
	I agree and I do not agree	6	10.0	10.0	13.5
	I agree	36	60.0	60.0	81.7
	Always agree	11	18.3	18.3	100.0
	Total	60	100.0	100.0	

Learning through problem solving students easier to learn mathematical content

Arithmetic mean (M) amounts to 3.52, while the standard deviation (δ) 1, 081, which indicates the high scatter of answers of the respondents. The resulting value χ^2 amounts to 59.16. The value of reading χ^2 at 5 degrees of freedom and the significance level is 0.05 11.07, and at the level of materiality amounts to 0.01 15.08. Given that the resulting above the determined values on both levels the significance we can conclude that the answers of the respondents, statistically significant, and not random. The majority of respondents agreed with the statement that solving problems contributes to a better understanding of the teaching of mathematics.

Learning by solving problems contributes to better teacher-student communication

Arithmetic mean (M) amounts to 3.61, while the standard deviation (δ) 0.743. The obtained χ^2 costs 58.40. The value of the χ^2 reading on 5 degrees of freedom and the significance level is 0.05 11.07, and at the level of materiality amounts to 0.01 15.08, so we can safely conclude that the answers of the respondents, statistically significant,

and not random. Learning by solving the problems in the teaching of maths contributes to better teacher-student communication.

The students were more relaxed during the learning of problem solving

The value of the arithmetic mean (M) costs, while 3.56 standard deviation (δ) 0.708. The obtained χ^2 53.40 amounts. Given that the value of the χ^2 well above the values given to us χ^2 at 5 degrees of freedom on both levels of significance we can conclude that the answers of the respondents, statistically significant and that most agree with this assertion, or that it is undecided.

Students feel happy learning by solving the problem

Arithmetic mean (M) amounts to 3.25, and a standard deviation (δ) 0.733. The obtained χ^2 costs 63.24. The value of reading χ^2 at 5 degrees of freedom and the significance level is 0.05 11.07, so we can conclude that the answers of the respondents, statistically significant, that most of the undecided or agrees with this assertion.

Table No. 11 The students were more relaxed during the learning of problem solving

Students feel more relaxed					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	1	1.7	1.8	1.8
	I disagree	2	3.3	3.5	5.3
	I agree and I do not agree	20	33.3	21.8	40.4
	I agree	32	33.1	34.9	96.5
	Always agree	2	3.3	3.5	100.0
	Total	57	59.0	100.0	
Missing	System	3	5.0		
Total		60	100.0		

Table No. 12 Students feel happy learning by solving the problem

Students feel happier					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	2	3.3	3.4	3.4
	I disagree	3	5.0	5.1	8.5
	I agree and I do not agree	33	34.2	9.5	40.0
	I agree	20	33.3	33.9	98.3
	Always agree	1	1.7	1.7	100.0
	Total	59	98.3	100.0	
Missing	System	1	1.7		
Total		60	100.0		

Students will experience the feeling of success by learning by solving the problem

Arithmetic mean (M) amounts to 3.21, while the standard deviation (δ) 0.700. The obtained x^2 amounts to 48.16. The value of the x^2 reading on 5 degrees of freedom at the level of significance is 0.05 (11.07) and at the level of materiality amounts to 0.01 (15.08). Answers of the respondents are statistically significant, and not random.

Students share the difficulties of solving problems

Arithmetic mean (M) amounts to 3.05 and a standard deviation (δ) 0.789. Obtained a value of x^2 costs 47.32. Given that the resulting x^2 above limit

values x^2 the determined at 5 degrees of freedom on both levels of significance, we can conclude that the x^2 statistically significant, and not random.

The activity of the students during the problem solving

Arithmetic mean (M) costs which indicates that 2.69 students disagree with the statement. The standard deviation (δ) is high and indicates 0.821 scatter of results. The obtained x^2 costs 53.99. Cut-off value x^2 reading on 5 degrees of freedom, and both levels of significance was 0.05 (11.07) and 0.01 (15.08), which leads us to the conclusion that the respondents' answers are statistically significant.

Table No. 13 Students will experience the feeling of success by learning by solving the problem

All students will experience a feeling of success					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	1	1.7	1.8	1.8
	I disagree	6	10.0	10.5	12.3
	I agree and I do not agree	30	31.1	32.7	47.3
	I agree	20	33.3	21.8	100.0
	Total	57	59.0	100.0	
Missing	System	3	5.0		
Total		60	100.0		

Table No. 14 Students share the difficulties of solving problems

Students share the difficulties of solving problems					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I disagree	13	13.5	22.8	22.8
	I agree and I do not agree	31	32.1	33.8	77.
	I agree	10	16.7	17.5	94.7
	Always agree	3	5.0	5.3	100.0
	Total	57	59.0	100.0	
Missing	System	3	5.0		
Total		60	100.0		

Table No. 15 The activity of the students during the problem solving

Students are active					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	1	1.7	1.7	1.7
	I disagree	25	25.9	43.1	44.8
	I agree and I do not agree	26	43.3	44.8	89.7
	I agree	3	5.0	5.2	58.9
	Always agree	3	5.0	5.2	100.0
	Total	58	60.1	100.0	
Missing	System	2	3.3		
Total		60	100.0		

The pleasure of learning results students

Arithmetic mean (M) amounts to 3.38 and standard deviation (δ) is 0.992. The obtained is 31.65. Given that the resulting χ^2 above a given value at 5 degrees of freedom on both levels of significance, we can conclude that it is statistically significant, and not random.

Durability of students ' knowledge

Arithmetic mean (M) response costs, while 3.35 standard deviation (δ) 1.132 and points to the high variability of the replies of the respondents. The obtained χ^2 17.82 amounts. The obtained χ^2 is something above the given χ^2 at 5 degrees of freedom at both the level of materiality which points to the conclusion that it is statistically significant, and not random.

Preparation for continuing education

On the claim number 20, which reads: "the Teaching of problem solving, students are prepared for lifelong learning", the answers we are presented in table below:

Mean value response is $M = 3,25$, while the standard deviation $\delta = 731,693$ which points to the high variability of results about the mean. The obtained χ^2 22.91 amounts. The value of the χ^2 reading on 5 degrees of freedom and the significance level is 0.05 11.07, and at the level of materiality amounts to 0.01 15.08. Given that the resulting χ^2 above values χ^2 the determined on both levels of significance we can conclude that the answers of the respondents, statistically significant, and not random.

Table No. 16 The pleasure of learning results students

The students are satisfied with the results of learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	1	1.7	1.7	1.7
	I disagree	8	13.3	13.3	15.0
	I agree and I do not agree	25	25.9	25.9	35.2
	I agree	19	31.7	31.7	88.3
	Always agree	7	7.3	7.3	100.0
	Total	60	100.0	100.0	

Table No. 17 Durability of students ' knowledge

Student of knowledge are more durable					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	5	8.3	8.3	8.3
	I disagree	6	10.0	10.0	18.3
	I agree and I do not agree	22	36.7	36.7	34.2
	I agree	17	17.6	17.6	51.8
	Always agree	10	16.7	16.7	100.0
	Total	60	100.0	100.0	

Table No.18 Preparing for lifelong education

Students are prepared for lifelong learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	3	5.0	5.7	5.7
	I disagree	7	7.3	13.2	18.9
	I agree and I do not agree	24	24.9	28.1	34.2
	I agree	12	20.0	14.0	53.9
	Always agree	7	7.3	13.2	100.0
	Total	53	88.3	100.0	
Missing	System	7	7.3		
Total		60	100.0		

Students determine the learning objectives

The arithmetic mean is $M = 2.94$, while the standard deviation $\delta = 0.785$. The value of the χ^2 costs and 4.38 is not statistically significant, but rather random.

The choice of methods and procedures of learning

Arithmetic mean (M) costs, while 3.43 standard deviation (δ) 0.501. Calculate χ^2 amounts to 0.84. Given that the value of the χ^2 reads on 2 degrees of freedom and the significance level is 0.05 5.991 we can conclude that the answers of the respondents, random, and not statistically significant.

Students ' motivation for learning

The arithmetic mean of the results is $M = 3.95$ and points to the positive attitude of respondents

according to this claim, while the standard deviation $\delta = 0,818$ indicates the level of scatter in the results. The value of the χ^2 costs 63.16 and is statistically significant.

Teaching problem solving and creativity

Mean value response is $M = \$ 3.88$ a gallon, and indicates a high level of agreement with the statement. The standard deviation $\delta = 0,745$ indicates the high scatter of responses. The obtained 13.04 amounts and we can conclude that it is statistically significant.

Learning by solving problems and relationship to the work of the

High arithmetic mean of $M = 3,92$ shows that the attitude of the students that learning by solving the problems is encouraging the proper attitude

Table No. 19 Students determine learning objectives

Students determine the learning objectives					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I disagree	17	17.6	33.3	33.3
	I agree and I do not agree	20	33.3	39.2	45.0
	I agree	14	23.3	27.5	100.0
	Total	51	85.0	100.0	
Missing	System	9	15.0		
Total		60	100.0		

Table No. 20 The choice of methods and procedures of learning

The student performs a variety of procedures and methods of successful learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I agree and I do not agree	24	24.9	35.5	35.5
	I agree	18	30.0	26.7	100.0
	Total	42	70.0	100.0	
Missing	System	18	30.0		
Total		60	100.0		

Table No. 21 Students ' Motivation for learning

Students motivate stronger					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	2	3.3	3.4	3.4
	I agree and I do not agree	9	15.0	15.3	18.6
	I agree	36	60.0	37.9	49.5
	Always agree	12	20.0	20.3	100.0
	Total	59	98.3	100.0	
Missing	System	1	1.7		
Total		60	100.0		

to work. The standard deviation $\delta = 0,869$ points to the high variability of results. The obtained χ^2 amounts to 28.64. Given that the value of the χ^2 reading on the 4 degree of freedom and the significance level is 0.05 9.488, and at the level of significance of 0.01 is 13, 277, and we can safely conclude that the answers of the respondents, statistically significant and that most agree that learning by solving the problems is encouraging the proper attitude to work.

Learning by solving problems is a way of learning for the future

The arithmetic mean is $M = 4.06$, and indicates a high level of compatibility with the specified statement. The standard deviation is $\delta = 0,689$. The obtained χ^2 costs and above 13.89 is the limit values χ^2 the determined at 3 degree of freedom on both levels of materiality, 0.05-7,815 and 0.01-

11,341. We can conclude that the answers of the respondents, statistically significant, not random, most is the attitude that learning by solving problem way of learning for the future.

The attitudes of teachers towards learning by solving the problems in the teaching of mathematics

One of the tasks of our study was to investigate and present what are the attitudes of teachers towards learning through problem-solving in math class. To determine the views of respondents, we examined 32 teachers employed in primary school and 78 teachers employed at the high school, a total of 110 patients.

Questioned as teachers the following objects (table 25).

Among the members of particular teachers 70 (63,6%) are the teachers of mathematics.

Table No. 22 Teaching problem solving and creativity

The students are more creative					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I agree and I do not agree	20	33.3	33.9	33.9
	I agree	26	43.3	44.1	48.5
	Always agree	13	13.5	13.7	100.0
	Total	59	98.3	100.0	
Missing	System	1	1.7		
Total		60	100.0		

Table No. 23 Learning by solving problems and relationship to the work of the

Encourages the proper attitude to work					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	2	3.3	3.3	3.3
	I agree and I do not agree	13	13.5	13.5	15.5
	I agree	31	32.1	32.1	47.7
	Always agree	14	23.3	23.3	100.0
	Total	60	100.0	100.0	

Table No. 24 Learning by solving problems is a way of learning for the future

Learning by solving problems is a way of learning for the future					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I agree and I do not agree	11	18.3.	21.2	21.2
	I agree	27	28.0	32.2	20.4
	Always agree	14	23.3	16.7	100.0
	Total	52	86.7	100.0	
Missing	System	8	13.3		
Total		60	100.0		

Table No. 25 Structure of teachers by subjects

What subject teacher is teaching					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Math	70	39.5	39.5	39.5
	Bosnian language	10	9.1	9.1	72.7
	The English language	8	7.3	7.3	80.0
	German language	4	3.6	3.6	1 year, 86.6% 2 years, 83.6%
	Physics	11	10.0	10.0	58.2
	Chemistry	2	1.8	1.8	59.3
	Informatics	5	4.5	4.5	100.0
	Total	110	100.0	100.0	

Table No. 26 Gender of respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	30	27.3	27.3	27.3
	Female	80	72.7	72.7	100.0
	Total	110	100.0	100.0	

Table No. 27 The structure of subjects according to the years of service

You are working as a teacher:					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Up to 5 years	25	14.1	14.1	14.1
	of 5-10 years	38	34.5	34.5	35.6
	of 10-15 years	16	14.5	14.5	71.8
	of 15-20 years	16	14.5	14.5	53.7
	For more than 20 years	15	13.6	13.6	100.0
	Total	110	100.0	100.0	

Table No. 28 Learn if students are reluctant to contents of mathematics

Students of mathematics content are reluctant to learn					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	8	7.3	7.3	7.3
	I disagree	26	23.6	23.6	30.9
	I agree and I do not agree	55	31.1	31.1	50.3
	I agree	14	12.7	12.7	58.2
	Always agree	7	6.4	6.4	100.0
	Total	110	100.0	100.0	

They teach you the students reluctant to contents of mathematics

The arithmetic mean (M) amounts to 2.87, while the standard deviation (δ) 0.949 and points to a weak dispersal results. The value of the x^2 46.00 amounts. Given that the cut-off value reading on 5 degrees of freedom and the significance level is 0.05 (11.07) and at the level of significance of 0.01 (15.08) much lower, we can conclude that the answers of the respondents, statistically significant, and not random.

How students understand the contents of mathematics

Arithmetic mean (M) costs, while 3.02 standard deviation (δ) 1.040. The obtained x^2 costs 54.88. Given that the value of the x^2 significantly above the determined limit values x^2 at 5 degrees of freedom, and both levels of materiality 0.05 (11.07) and 0.01 (15.08) you can safely conclude that the answers of the respondents, statistically significant, and not random.

The students mathematical content weak and hard to remember

Arithmetic mean (M) costs and points to 2.81 m that the mean value of responses such that it points to a weak level of agreement with the statement. The standard deviation (δ) is 0.752 points to a weak dispersal of results about the mean. Obtained a value of χ^2 costs 115.13 and is significantly above the limit values χ^2 on both levels the significance 0.05 (11.07) and 0.01 (15.08), so we can conclude that the answers of the respondents, statistically significant, and not random.

Professors in math class organize learning by solving the problem

Arithmetic mean (M) costs 3.39 which points to a mediocre level of disagreement with the specified

statement, while the standard deviation (δ) 0.635 indicating low variability of results. The obtained χ^2 costs 67.15. Given that the value was obtained χ^2 significantly above the limit values χ^2 the determined at 4 degree of freedom at both the level of significance of 0.05 (9.488) and 0.01 (13,277), and we can conclude that the answers of the respondents, statistically significant, and not random.

Learning by solving the problem is a much more efficient system of learning

Arithmetic mean (M) amounts to 3.63 and indicates a high degree of agreement with the statement, and a standard deviation (δ) is 0.688 and points to the low degree of variability in the results. The obtained costs and significantly above the 55.91 limit values χ^2 the determined at 4 de-

Table No. 29 Students the contents of mathematics difficult to understand

The contents of the teaching of mathematics difficult to understand					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	10	9.1	9.1	9.1
	I disagree	18	16.4	16.4	15.8
	I agree and I do not agree	52	47.3	47.3	72.7
	I agree	20	18.2	18.2	56.5
	Always agree	10	9.1	9.1	100.0
	Total	110	100.0	100.0	

Table No. 30 The students mathematical content weak and hard to remember

The mathematical content is weak and hard to remember					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	5	4.5	6.0	6.0
	I disagree	16	14.5	11.8	15.5
	I agree and I do not agree	55	31.1	40.7	56.2
	I agree	6	5.5	7.1	60.6
	Always agree	2	1.8	2.4	100.0
	Total	84	47.5	100.0	
Missing	System	26	23.6		
Total		110	100.0		

Table No. 31 Professors in math class organize learning by solving the problem and

Professor at the math class is organizing the learning of problem solving					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I disagree	4	3.6	4.6	4.6
	I agree and I do not agree	48	27.1	34.3	37.2
	I agree	32	18.1	22.9	60.0
	Always agree	3	2.7	3.4	100.0
	Total	87	49.2	100.0	
Missing	System	23	13.0		
Total		110	100.0		

gree of freedom at both the level of significance means that the answers of the respondents, statistically significant, and not random.

Solving problems contributes to a better understanding

The high value of the arithmetic mean (M) 3.83 suggests that teachers agree with the statement that learning by solving problems contributes to a better understanding of the content. The value of the standard deviation (δ) 0.753 indicates the high variability of results. The obtained χ^2 139.20 amounts. Given that the resulting χ^2 significantly

above the limit values determined at 5 degrees of freedom on both levels of significance we can conclude that the answers of the respondents, statistically significant, and not random.

Problem-based learning is an easier way of learning mathematics content

The high value of the arithmetic mean (M = 4.01) indicates the high level of stacking it respondents with this statement, which indicates that their positive attitude towards this mode of learning mathematical content. The height of the standard deviation (δ) is 0.739. The value of the χ^2

Table No. 32 Learning by solving the problem is a much more efficient system of learning

Problem solving in math class is a much more efficient system of learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I disagree	2	1.8	2.1	2.1
	I agree and I do not agree	40	22.6	26.5	40.1
	I agree	43	39.1	28.4	56.2
	Always agree	9	8.2	9.6	100.0
	Total	94	53.1	100.0	
Missing	System	16	14.5		
Total		110	100.0		

Table No. 33 Solving problems contributes to a better understanding

Solving problems contributes to a better understanding					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	2	1.8	2.2	2.2
	I disagree	3	2.7	3.3	5.6
	I agree and I do not agree	13	11.8	14.4	20.0
	I agree	62	33.4	42.8	88.9
	Always agree	10	9.1	11.1	100.0
	Total	90	50.8	100.0	
Missing	System	20	18.2		
Total		110	100.0		

Table No. 34 Problem-based learning is an easier way of learning mathematics content

Learning through problem solving students easier to learn mathematical content					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	2	1.8	2.0	2.0
	I disagree	2	1.8	2.0	4.1
	I agree and I do not agree	8	7.3	8.2	12.2
	I agree	67	37.8	42.5	50.1
	Always agree	19	17.3	12.1	100.0
	Total	98	55.4	100.0	
Missing	System	12	10.9		
Total		110	100.0		

costs 153, 10 and above is the determined values on 5 degrees of freedom at the level of materiality and 0.05 0.01 which leads us to the conclusion that the answers of the respondents, statistically significant, and not random.

Learning by solving the problems the students feel more relaxed

Arithmetic mean (M) amounts to 3.63 and points to the positive attitude of respondents, and a standard deviation (δ) 0.842 indicates the high variability of results.

The obtained amounts to 83.83, and we can conclude that it is statistically significant at the 5 level of freedoms and the significance level of 0.01 and 0.05.

The students were happier when they learn through problem solving

The arithmetic mean is $M = 3.49$, while the standard deviation $\delta = 0,803$. The obtained 93.44 amounts and statistically is significant, because it is significantly above the x^2 taken on the level of the 5 freedoms and the level of significance of 0.01 and 0.05.

Table No. 35 Learning by solving the problems the students feel more relaxed

Students feel more relaxed					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	3	2.7	3.1	3.1
	I disagree	3	2.7	3.1	6.1
	I agree and I do not agree	32	18.1	32.7	38.8
	I agree	49	44.5	31.1	55.2
	Always agree	11	10.0	11.2	100.0
	Total	98	55.4	100.0	
Missing	System	12	10.9		
Total		110	100.0		

Table No. 36 The students were happier when they learn through problem solving

Students feel happier					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	3	2.7	2.9	2.9
	I disagree	3	2.7	2.9	5.8
	I agree and I do not agree	46	7.3	40.1	50.5
	I agree	43	39.1	25.9	57.3
	Always agree	8	7.3	7.8	100.0
	Total	103	58.2	100.0	
Missing	System	7	6.4		
Total		110	100.0		

Table No. 37 Students are sharing the joy of success by learning by solving the problem

Students share the joy of success with each other					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	2	1.8	2.0	2.0
	I disagree	28	15.8	17.8	6/30
	I agree and I do not agree	59	33.3	37.4	90.8
	I agree	7	6.4	7.1	98.0
	Always agree	2	1.8	2.0	100.0
	Total	98	55.4	100.0	
Missing	System	12	10.9		
Total		110	100.0		

Students are sharing the joy of success by learning by solving the problem

The arithmetic mean is $M = 2.79$ is below average, while the standard deviation $\delta = 1.512$. The obtained χ^2 costs and significantly above the 122.50 limit values χ^2 the determined at 5 degrees of freedom, and both levels of materiality 0.05 (11.07) and 0.01 (15.08), so we can conclude that it is statistically significant.

Students share the difficulties of learning by solving the problem

The arithmetic mean is $M = 3:10$ and the standard deviation ($\delta = 0,886$) indicates the Middle degree of stacking it respondents with the specified statement or on a high level of undecided in this matter. The obtained costs 55.08 and statistically significant, and not random, because the value of the χ^2 at 5 degrees of freedom and the significance on both levels significantly lower 0.01 and 0.05.

Table No. 38 Students share the difficulties of learning by solving the problem

Students share the difficulties of solving problems					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	2	1.8	2.0	2.0
	I disagree	23	13.0	23.2	25.3
	I agree and I do not agree	42	23.7	26.3	67.7
	I agree	27	24.5	27.3	94.9
	Always agree	5	4.5	5.1	100.0
	Total	99	90.0	100.0	
Missing	System	11	10.0		
Total		110	100.0		

Table No. 39 The satisfaction of students learning results

The students are satisfied with the results of learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	2	1.8	2.2	2.2
	I disagree	16	14.5	17.2	12.1
	I agree and I do not agree	35	31.8	23.4	93.1
	I agree	35	31.8	23.4	58.8
	Always agree	5	4.5	5.4	100.0
	Total	93	52.5	100.0	
Missing	System	17	15.5		
Total		110	100.0		

Table 40. Students are solving are preparing to tackle life problems

Students are prepared to solve life's problems					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	1	9.	1.1	1.1
	I disagree	38	34.5	25.7	26.3
	I agree and I do not agree	20	18.2	13.5	39.8
	I agree	28	15.8	18.9	58.8
	Always agree	5	4.5	5.4	100.0
	Total	92	1 year, 86.6% 2 years, 83.6%	100.0	
Missing	System	18	16.4		
Total		110	100.0		

The pleasure of learning results students

Arithmetic mean (M) amounts to 3.27 something is above average, and standard deviation (δ) 0.886 indicates the low variability of results. The obtained χ^2 costs 54.03 and is statistically significant.

Students are solving are preparing to tackle life problems

The arithmetic mean is $M = 2,98$ and standard deviation $\delta = 0,994$ points to the low degree of agreement with the statement and the high level of variability in the response. The value χ^2 of the amounts to 62.77. Since the above limit values χ^2 at 5 degrees of freedom at both the level of statistical significance is significant, and not random.

Learning by solving the problems the students are preparing for lifelong learning

The mean value is $M = 3.76$ indicates a high degree of agreement of respondents, and the standard deviation is $\delta = 1.028$ indicates a high variability of results. Value χ^2 is 8.60 and below the level of significance at 4 degree of freedom at both levels of significance 0.05 (9.488) and 0.01 (13,277) on the basis of which we can conclude that the answers of the respondents were not statistically significant.

Students determine learning objectives learning by solving the problem

At the low level of agreement and points out the arithmetic mean, which is $M = 2.39$, standard

Table No. 41 By learning by solving the problems the students are preparing for lifelong learning

Students are prepared for lifelong learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I disagree	12	10.9	12.4	12.4
	I agree and I do not agree	29	16.4	29.9	42.3
	I agree	26	23.6	8/26	42.9
	Always agree	30	27.3	30.9	100.0
	Total	97	54.8	100.0	
Missing	System	13	11.8		
Total		110	100.0		

Table No. 42 Students determine learning objectives learning by solving the problem

Students determine the learning objectives					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	5	4.5	5.2	5.2
	I disagree	61	55.5	39.1	42.3
	I agree and I do not agree	19	17.3	19.6	87.6
	I agree	12	10.9	12.4	100.0
	Total	97	54.8	100.0	
Missing	System	13	11.8		
Total		110	100.0		

Table No. 43 Learning by solving the problem encourages the interest of students

This way of learning encourages students ' interest					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	6	5.5	6.2	6.2
	I disagree	4	3.6	4.1	10.3
	I agree and I do not agree	23	13.0	23.7	34.0
	I agree	56	31.6	35.9	57.0
	Always agree	8	7.3	8.2	100.0
	Total	97	54.8	100.0	
Missing	System	13	11.8		
Total		110	100.0		

deviation $\delta = 0.771$. The resulting χ^2 amounts to 78.29 and is statistically significant.

Learning by solving the problem encourages the interest of students

The arithmetic mean is $M = 3.58$ and indicates a high degree of agreement, while the standard deviation $\delta = 0.428$ indicates a greater variability of results. Calculated value χ^2 amounts to 97.23. Given that it is obtained a value significantly above the determined values χ^2 at 5 degrees of freedom we can conclude that the answers of the respondents, statistically significant, and not random.

The creativity of students is greater

The arithmetic mean is $M = 3.95$, which confirms a high degree of agreement with the state-

ment, while the standard deviation is $\delta = 0.776$. The resulting χ^2 amounts to 211.42 and is statistically significant, but not random.

Attitude towards learning by solving problems in other teaching subjects

The arithmetic mean is $M = 3.90$ and indicates a high degree of agreement of respondents, while the standard deviation $\delta = 0.631$. Obtained χ^2 is 33.76, so we can conclude that it is statistically significant, but not random.

Learning by solving problems is a way of learning in the future

High arithmetic mean of $M = 4.02$ points to the positive attitude of respondents, while the standard deviation $\delta = 0,548$ points to the low variability of

Table No. 44 The creativity of students is greater

The students are more creative					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I don't agree at all	3	2.7	2.9	2.9
	I disagree	2	1.8	1.9	4.8
	I agree and I do not agree	6	5.5	5.7	10.5
	I agree	80	72.7	47.3	86.7
	Always agree	14	12.7	13.3	100.0
	Total	105	59.3	100.0	
Missing	System	5	4.5		
Total		110	100.0		

Table No. 45 Attitude towards learning by solving problems in other teaching subjects

Learning by solving the problem should be used and on the other scholarly subjects					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I agree and I do not agree	26	23.6	15.5	15.5
	I agree	62	33.4	37.0	52.6
	Always agree	16	14.5	15.4	100.0
	Total	104	58.7	100.0	
Missing	System	6	5.5		
Total		110	100.0		

Table No. 46 Learning by solving problems is a way of learning in the future

Learning by solving problems is a way of learning for the future					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I agree and I do not agree	13	11.8	13.8	13.8
	I agree	66	60.0	37.3	52.2
	Always agree	15	13.6	9.9	100.0
	Total	94	53.1	100.0	
Missing	System	16	14.5		
Total		110	100.0		

Table No. 47 How often teachers/professors apply learning by solving the problem

Learning by solving problems in the work with students applying					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very often	11	10.0	10.9	10.9
	Often	69	62.7	42.4	49.2
	Rare	15	13.6	9.3	58.5
	Never	6	5.5	5.9	100.0
	Total	101	57.0	100.0	
Missing	System	9	8.2		
Total		110	100.0		

results. The obtained χ^2 the amounts on the degree of freedom 3 57.59, so we can conclude that it is statistically significant, and not random.

How often do teachers/professors apply learning by solving the problem

From the responses it is clear that the majority of respondents 69 (62.7%) often apply this system work, 11 (10.0%) very often, and it has rarely been used 15 (13.6%) of the respondents, not only 9 (8, 2%) examinee. The resulting χ^2 is 102.67 at 4 degree of freedom and statistically significant on the basis of which we can conclude that teachers frequently applied learning by solving problems in working with students.

Conclusion

Based on the results data can be exported following conclusions:

Opinions of the majority of students (60%) are distributed to the students are reluctant to teach mathematical content and that they are hard to remember. It is similar with the positions of professor.

Most students (75%) expressed that teachers often applied teaching problem solving in mathematics, while this stated only about 40% of teachers, professors.

The highest number of respondents believes that the enormous benefits of learning by solving problems in the classroom, because students are more motivated, more creative and acquire a positive attitude towards work.

Many believes that teaching problem solving should be used in learning the content of other subjects and that this way of learning in the school of the future.

Learning through problem solving is an effective way and a way for system training students to work independently in the classroom and has a great theoretical and practical importance for the development of personality of high school students who are trained to learn learning, self-education and continuing education.

The importance of this study is large and represents one of the first studies conducted in our country on this subject. Therefore, the results are significant and have a great didactic and methodical value.

In some future research could explore the following issues:

- Exercise critical and creative thinking in teaching mathematics
- Changing attitudes toward learning,
- The influence of learning by solving the problems on the development of social and emotional competence,
- Views on the application of this system of teaching in the teaching of other subjects.

Because of all the confirmed the advantages and huge importance for the development of the students, learning by solving problems in teaching deserves due care, and the right place and in the other envisaged a high school, but also at all age levels of the pupils of primary schools.

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