IMVI *ISSN (p) 2303-4882, ISSN 1840-4383*
Open Mathematical Education Notes
Vol. 6(2016), 5-18
www.imvibl.org / JOURNALS / IMVI OMEN

The Importance of Preparation Classes for Taking the University Entrance Examination in Mathematics

Snježana Maksimović

Faculty of Electrical Engineering, University of Banja Luka, Patre 5,
78000 Banja Luka, Bosnia and Herzegovina
E-mail: snjezana.maksimovic@etfbl.net

Ivan – Vanja Boroja

Faculty of Electrical Engineering, University of Banja Luka, Patre 5,
78000 Banja Luka, Bosnia and Herzegovina
E-mail: ivan-vanja.boroja@etfbl.net

Abstract. In this paper we analyze a mathematics test taken by undergraduate candidates during the university entrance examinations for enrolment to the Faculty of Electrical Engineering at the Banja Luka University, Bosnia and Herzegovina, in the academic year 2015/2016. We also analyze the importance of preparation classes for taking the university entrance examination, as well as the candidates' achievement on the entrance examination relative to the secondary school attended and secondary school average score in mathematics. The results of the analysis are presented using descriptive statistics and relevant tests of the SPSS statistical analysis software package. A strong statistically significant difference, in terms of the number of points between the candidates who have attended preparatory classes and those who did not has been revealed.

Keywords: entrance examination, mathematical education, preparation classes, undergraduate studies

Introduction

Mathematics is a significant topic supporting a large number of engineering courses and consequently, it is important for engineering students to hold a strong mathematics fundamental knowledge that can keep their motivation for equitable progress of their engineering programs. A lot of researchers in Mathematics Education domain are interested in universities entrance mathematics tests. Pyle [23] stated that engineering as a profession requires a clear understanding of mathematics, sciences and technology. Sazhin [29] mentioned that engineering graduate acquires not only a practical but also abstract understanding of mathematics. Therefore, it is crucial that in university level, most of programs of study require mathematics, at which the ability to mathematical skills are important indicator of potential for students in all levels of academics end endeavors (Tang [32] et al.). Lawson [19] found that changes in basic mathematical knowledge have direct effect to many mathematical skills that are essential for those undergraduate degree courses with a significant mathematical content. This is the consequences of students' prior experiences and knowledge they earned from pre-university learning process. In recent years, it was found that there is a serious decline in students' basic mathematical skills and level of preparation on entry into Higher Education.

Within the last decade, a higher interest has been observed for enrollment to the technical departments of the universities in Bosnia and Hercegovina, especially to the faculties of Electrical Engineering. A similar situation can be observed in the neighboring countries, such as Serbia and Croatia (see [11]). However, it has been observed that the secondary school knowledge of undergraduate candidates is considerably inferior to before in comparison with the previous decades (see, for example: [17], [24-28]).

Studies at the Faculty of Electrical Engineering are organized according to the model of the European Credit Transfer and Accumulation System (ECTS) and take place in three cycles. The study programs in the first cycle are: Computer and Information, Electronics and Telecommunications, and Electric Power and Industrial Systems. The entrance examination is taken only in Mathematics, which is 'the biggest problem' for the candidates, by our opinion. Gill [5, 6] has studied problems that students of physics and engineering have with mathematics and Jackman [10] et al. report on a project involving assessment tasks designed to improve the ability of students to apply/use mathematics in context.

Faculty of Electrical Engineering in Banja Luka organizes the preparation classes for the entrance examination for 20 (short, one week course) or 50 (long, three months course) hours. The material presented in the preparation classes covers all areas that come up in the entrance examination. These are: rationalization of algebraic expressions ([1]), quadratic equations and inequalities, rational and irrational equations and inequalities ([34]), logarithmic and exponential functions ([2]), trigonometric equations, inequalities and identities ([21]), systems of linear and square equations, analytic geometry ([4]).

Below, the analysis of the mathematics test results that we obtained during the presentation of the preparation classes for a period of 20 and 50 hours will be given. There are many papers which analyze candidates' achievement related to the university entrance examination. We refer here just to a few of them: (see [15, 16, 18, 19, 22, 25, 26, 27]).

Theoretical backgrounds

There is an extensive literature concentrated on predicting student performance. This literature uses mainly correlation analysis and the main conclusion from these studies is that up to 15[1] percent of an individual's future educational success can be explained with factors that are observable at the time of the admission. The general finding is that grade point averages from previous school and aptitude test scores provide the best forecast of success, whether the success is measured as grades or completion of higher education.

Mathematical tasks are important for teaching, and the nature of student learning is determined by the type of task and the way it is used (see [14,31]). Stein and Henningsen in [9] developed a conceptual framework that defines a mathematical task as a classroom activity, the purpose of which is to focus students' attention on a particular mathematical concept, idea, or skill. In this framework mathematical tasks pass through three phases: as written by curriculum developers, as set up by the teacher in the classroom, and as implemented by students during the lesson. They also have two dimensions: task features and cognitive demand. Kaur [13] focused on nature and source of mathematical tasks, which specifically are learning, review, practice and assessment tasks. For our purposes we concentrate on assessment tasks which are tasks used to assess the performance of the students. Koh and Lee in [15] created and validated six standards for scoring assessment tasks: depth of knowledge, knowledge criticism, knowledge manipulation, supportive task framing, clarity and organization, and explicit performance standard or marking criteria.

Kaiser and Willander [12], when designing or modifying existing mathematical tasks in their study,

[1] According to paragraph 6.6 of the General provisions for submission to the University of Banja Luka have the right to enroll candidates at the entrance examination did not achieve at least 15 points.

come out from PISA Study' definition of mathematical literacy and its features: 'Mathematical Literacy is assessed by giving students 'authentic' tasks – based on situate ions which, while sometimes fictional, represent the kinds of problem encountered in real life'. They base on different levels of mathematical literacy: illiteracy, nominal literacy, functional literacy, conceptual literacy, procedural literacy and multidimensional literacy.

Hence, appropriate aspects of the works of Henningsen and Stein [9], Kaur [13], Koh and Lee [15], Shafer and Foster [30] and Kaiser and Willander [12], Kohanova [16] contributed towards the division of our entrance test tasks into 4 categories. Their description is in the following table.

Table 1 *Knowledge categories*

Category	*Elementary knowledge*	*Intermediate knowledge*	*Advanced knowledge*	*Nontrivial tasks*
Description	simple problems, functional literacy	relationships among mathematical concepts and procedures, conceptual literacy	difficult problems, Pattern recognition, procedural Literacy	application of knowledge or new given definition (comprehension) in unfamiliar context, multidimensional literacy

Motivation

During the last decade the Faculty of Electrical Engineering organized preparatory courses in mathematics. Our subjective view about the influence of preparatory classes on the candidates' progress is positive. Those preparatory courses helped candidates to develop the self-confidence and increase the score at the entrance examination. Our motivation was to scientifically verify our opinion and evaluate effects as well as search for possible improvements.

Sample and Organization of Research

Below, we analyze and statistically compare the results achieved by the candidates at the entrance examination in relation to the length of the completed preparation classes (short and long courses) and the impact of their secondary school grade point average in mathematics at laying the entrance examination in the academic 2015/2016 year.

A sample of our study consists of 291 candidates, out of which 180 candidates successfully passed the entrance examination. The preparation classes were taken by 117 candidates (70 candidates completed 20 hours, 47 candidates completed 50 hours). They could earn 50 points for their achievement at the entrance examination, consisting of 10 mathematics problems, of which each was assigned 5 points. The candidates needed to earn at least 15 points to pass the entrance examination.

Research Analysis and Results

The secondary schools completed by the competing candidates were grouped in four categories: Gymnasium /Grammar schools, Electrical Engineering schools, Other technical schools and Other schools. Table 2 shows the candidate structure according to secondary school completed and the achievement in mathematics test.

The candidates who had completed Gymnasium /Grammar schools had the highest secondary point average in mathematics (4.19), followed by the Other schools graduates (4.09), the third were the candidates from the Other technical schools group (4.00), and the fourth graduates of Electrical Engineering schools (3.73).

Table 2. *Candidate structure according to secondary school / high school and achievement in mathematics test*

			passed		
			Yes	no	Total
school	Gymnasium /Grammar High schools	Count	114	34	148
		% within passed	63.3%	30.6%	50.9%
	Electrical Engineering High School	Count	43	38	81
		% within passed	23.9%	34.2%	27.8%
	Other technical High School	Count	21	34	55
		% within passed	11.7%	30.6%	18.9%
	Other High Schools	Count	2	5	7
		% within passed	1.1%	4.5%	2.4%
	Total	Count	180	111	291
		% within passed	100.0%	100.0%	100.0%

Using the Mann-Whitney U test, it is shown a strong statistical significance of the secondary point average in mathematics between the candidates who graduated from Gymnasium/Grammar and of Electrical Engineering schools (p = .001), Electrical Engineering schools and Other technical schools (p = .009).

Analysis of Entrance Examination Test

In each problem 0 points is given for unsolved or incorrectly solved problem and 5 points is given for completely correctly solved problem. Below an analysis is given of the individual problems contained in the test.

Problem 1 Calculate the value of the expression $\left(\frac{x\sqrt{x}}{\sqrt{1-x^3}}+\frac{\sqrt{1-x^3}}{x\sqrt{x}}\right)^{-1}$ for $x=\sqrt[3]{\frac{a-\sqrt{a^2-b^2}}{2a}}$.

Goals of the task: *Algebraic procedural thinking*

Solution: In this problem the candidates are supposed to find the least common denominator of two expressions, know the characteristics of the absolute value and recognize the difference of squares. Points for partial solutions of this problem were awarded as follows:

1. Find $1-x^3$
2. Find least common denominator of two expressions
3. Insert the value of x
4. Recognize the difference of squares

Analysis: The candidates achieved on average of 2.32 points for this problem, with a statistical deviation of 2.156. The candidates who passed the entrance examination achieved on average of 3.04 (st. dev 1.686), and those who did not 0.99 (st. dev 1.352). The candidates who took the preparation course achieved on average of 2.72 (st. dev 1.701), and those who did not 1.95 (st. dev 1.894). The average points gained for this problem by the candidates who took the short preparation course (20 hours) was 2.63 (st. dev 1.687) and the average points by the candidates who took the long preparation course (50 hours) was 2.85 (st. dev 1.732). Candidates who both took the preparation classes and passed the entrance examination achieved on average of 2.93 points with st. dev. 1.631 (candidates who took the long preparation course and entrance examination achieved on average of 2.98 points and those who took the short preparation course and passed entrance examination achieved on average of 2.90).

Problem 2 Let x_1 and $x_2 (x_1, x_2 \neq 0)$ be the solutions of equation $x^2 - kx + k + 2 = 0$. Compile a quadratic equation whose solutions are $x_1 + \frac{1}{x_2}$ and $x_2 + \frac{1}{x_1}$ and determine the real parameter k of the compiled equation so that one solution is two times larger than the other.

Goals of the task: *Algebraic conceptual and processing thinking*

Solution: It is clear in this problem what candidates should determine, so the points for partial solutions of this problem were awarded as follows:

1- Apply the Viet's formula to the given equation
2- Find $x_1 + \frac{1}{x_2} + x_2 + \frac{1}{x_1}$ and $\left(x_1 + \frac{1}{x_2}\right) * \left(x_2 + \frac{1}{x_1}\right)$
3- Find the corresponding equation
4- Find one value of k ($k > 0$ or $k < 0$)

Analysis: The candidates achieved on average of 1.55 points for this problem, with a statistical deviation of 1.582. The candidates who passed the entrance examination achieved on average of of 2.27 (st. dev 1.592), and those who did not 0.39 (st. dev 0.508). The candidates who took the preparation course achieved on average of 2.15 (st. dev 1.555), and those who did not 1.16 (st. dev 1.476). The average points achieved for this problem by the candidates who took the short preparation course (20 hours) was 2.10 (st. dev 1.608) and the average points by the candidates who took the long preparation course (50 hours) was 2.21 (st. dev 1.488). Candidates who both took the preparation classes and passed the entrance examination achieved on average of 2.39 points with st. dev. 1.504 (candidates who took the long preparation course and entrance examination achieved on average of 2.37 points and those who took the short preparation course and passed entrance examination achieved on average of 2.41).

Problem 3 Determine a real parameter k such that the inequality

$$-3 < \frac{x^2 + kx - 2}{x^2 - x + 1} < 2$$

holds for every real$x$.

Goals of the task: *Algebraic conceptual and procedural thinking*

Solution: In this problem the candidates should conclude that the expression $x^2 - x + 1$ is always positive. This means that we can multiply the above inequality by $x^2 - x + 1$ without change of sign. We obtain $-3(x^2 - x + 1) < x^2 + kx - 2 < 2(x^2 - x + 1)$ which is equivalent to $4x^2 + (k-3)x + 1 > 0$ and $x^2 - (k+2)x + 4 > 0$. Reduce $4x^2 + (k-3)x + 1 > 0$ to $x^2 + \frac{k-3}{4}x + \frac{1}{4} > 0$. As the expression $x^2 + bx + c$ is positive if only if $D = b^2 - 4c < 0$ we obtain the result. The points for partial solutions of this problem were awarded as follows:

1- Conclude that $x^2 - x + 1 > 0$
2- Multiply the expression by $x^2 - x + 1$
3- Solve $4x^2 + (k-3)x + 1 > 0$

4- Solve $x^2 - (k+2)x + 4 > 0$

Analysis: The candidates achieved on average of 1.43 points for this problem, with a statistical deviation of 2.032. The candidates who passed the entrance examination achieved on average of je 2.14 (st. dev 2.207), and those who did not 0.29 (st. dev 0.908). The candidates who took the preparation course achieved on average of 2.05 (st. dev 2.204), and those who did not 1.02 (st. dev 1.797). The average points achieved for this problem by the candidates who took the short preparation course (20 hours) was 2.00 (st. dev 2.194) and the average points by the candidates who took the long preparation course (50 hours) was 2.13 (st. dev 2.242). Candidates who both took the preparation classes and passed the entrance examination achieved on average of 2.32 points with st. dev. 2.217 (candidates who took the long preparation course and entrance examination achieved on average of 2.33 points and those who took the short preparation course and passed entrance examination achieved on average of 2.32).

Problem 4 Solve the equation $\sqrt{x+5-4\sqrt{x+1}} - \sqrt{x-2\sqrt{x-1}} = 1$.

Goals of the task: *Algebraic conceptual and procedural thinking*

Solution: In this problem the candidates should find domain of equation, then notice that the expressions under the roots are the complete squares, so the problem is reduced to $\left|\sqrt{x+1}-2\right| - \left|\sqrt{x-1}-1\right| = 1$. The points for partial solutions of this problem were awarded as follows:

1- Find domain $x \geq 1$
2- Notice that the equation is reduced to $\left|\sqrt{x+1}-2\right| - \left|\sqrt{x-1}-1\right| = 1$
3- Solve equation in the case $x \in [1,2)$
4- Solve equation in the case $x \in [2,3)$

Analysis: The candidates achieved on average of only 0.99 points for this problem, with a statistical deviation of 1.419. The candidates who passed the entrance examination achieved on average of 1.51 (st. dev 1.555), and those who did not 0.14 (st. dev 0.464). The candidates who took the preparation course achieved on average of 1.79 (st. dev 1.611), and those who did not only 0.44 (st. dev 0.946). The average points achieved for this problem by the candidates who took the short preparation course (20 hours) was 1.74 (st. dev 1.548) and the average points by the candidates who took the long preparation course (50 hours) was 1.87 (st. dev 1.715). Candidates who both took the preparation classes and passed the entrance examination achieved on average of 2.01 points with st. dev. 1.595 (candidates who took the long preparation course and entrance examination achieved on average of 2.02 points and those who took the short preparation course and passed entrance examination achieved on average of 2.00).

Problem 5 Solve the inequality $log_x(x^2-6) < 1$.

Goals of the task: *Algebraic conceptual and procedural thinking*

Solution: In this problem the candidates should find domain of logarithmic function and notice that we should consider only the case when the base of logarithm is bigger than one. The points for partial solutions of this problem were awarded as follows:

1- Find domain $D = (\sqrt{6}, +\infty)$
2- Consider only the case when the base of logarithm is bigger then one
3- Using the properties of logarithm we obtain the inequality $x^2 - x - 6 < 0$
4- Solve the inequality $x^2 - x - 6 < 0$ $(x \in D)$.

Analysis: The candidates achieved on average of 2.54 points for this problem, with a statistical deviation of 1.901. The candidates who passed the entrance examination achieved on average of 3.49 (st. dev 1.612), and those who did not 0.99 (st. dev 1.179). The candidates who took the preparation course achieved on average of 3.23 (st. dev 1.788) and those who did not 2.07 (st. dev. 1.837). The average points achieved for this problem by the candidates who took the short preparation course (20 hours) was 2.89 (st. dev 1.774) and the average points by the candidates who took the long preparation course (50 hours) was 3.74 (st. dev 1.700). Candidates who both took the preparation classes and passed the entrance examination achieved on average of 3.57 points with st. dev. 1.576 (candidates who took the long preparation course and entrance examination achieved on average of 3.91 points and those who took the short preparation course and passed entrance examination achieved on average of 3.32).

Problem 6 Solve the equation $\sin x = \cos\frac{x}{2}$.

Goals of the task: *Algebraic conceptual and procedural thinking*

Solution: In this problem candidates are supposed to know a basic trigonometric formula and the values of basic trigonometric functions on the trigonometric circle. Points for partial solutions of this problem were awarded as follows:

1- Apply formula $\sin x = 2sin\frac{x}{2}cos\frac{x}{2}$
2- Recognize that equation is equivalent to conjunction of two equations
3- One point for every group of solutions founded.

Analysis: The candidates achieved on average of 1.87 points for this problem, with a statistical deviation of 2.133. The candidates who passed the entrance examination achieved on average of 2.91 (st. dev 2.089), and those who did not 0.18 (st. dev 0.508). The candidates who took the preparation course achieved on average of 2.92 (st. dev 2.138), and those who did not 1.20 (st. dev 1.816). The average points achieved for this problem by the candidates who took the short preparation course (20 hours) was 2.61 (st. dev 2.122) and the average points by the candidates who took the long preparation course (50 hours) was 3.38 (st. dev 2.101). Candidates who both took the preparation classes and passed the entrance examination achieved on average of 3.30 points with st. dev. 2.014 (candidates who took the long preparation course and entrance examination achieved on average of 3.65 points and those who took the short preparation course and passed entrance examination achieved on average of 3.05).

Problem 7 If $\cos\left(x+\frac{\pi}{6}\right)\cos\left(x-\frac{\pi}{6}\right)=m$, find $\cos x$.

Goals of the task: *Algebraic conceptual and processing thinking*

Solution: In this problem candidates are supposed to know trigonometric addition formulas and values of basic trigonometric functions at first quadrant ($x \in \left[0,\frac{\pi}{2}\right]$). Points for partial solutions of this problem were awarded as follows:

1- Apply a formula $\cos(\alpha)\cos(\beta) = \frac{1}{2}(\cos(\alpha+\beta)+\cos(\alpha-\beta))$ where $\alpha = x+\frac{\pi}{6}$ and $\beta = x-\frac{\pi}{6}$
2- Apply a formula $\cos(2x) = cos^2x - sin^2x$
3- Transform the given equation to the quadratic equation of the form $cos^2x = m+\frac{1}{4}$
4- Emphasize the condition for the final solution ($m \in [-\frac{1}{4},\frac{3}{4}]$).

Analysis: The candidates achieved on average of 1.78 points for this problem, with a statistical deviation of 1.817. The candidates who passed the entrance examination achieved on average of 2.68 (st. dev 1.707), and those who did not 0.32 (st. dev 0.716). The candidates who took the preparation course achieved on average of 2.64 (st. dev 1.699), and those who did not 1.20 (st. dev 1.662). The average points achieved for this problem by the candidates who took the short preparation course (20 hours) was 2.43 (st. dev 1.682) and the average points by the candidates who took the long preparation course (50 hours) was 2.96 (st. dev 1.693). Candidates who both took the preparation classes and passed the entrance examination achieved on average of 2.95 points with st. dev. 1.563 (candidates who took the long preparation course and entrance examination achieved on average of 3.23 points and those who took the short preparation course and passed entrance examination achieved on average of 2.75).

Problem 8 Solve the system of equations

$$\begin{cases} x + 2y + 3z = 232 \\ 8x + 9y + 4z = 539 \\ 7x + 6y + 5z = 544. \end{cases}$$

Goals of the task: *Algebraic and procedural thinking*

Solution: In this problem candidates are supposed to know to transform a system to an equivalent one and to solve system step by step. Points for partial solutions of this problem were awarded as follows:

1- Transform system to equivalent and easier to solve
2- One point per correct components

Analysis: The candidates achieved on average of 1.91 points for this problem, with a statistical deviation of 1.951. The candidates who passed the entrance examination achieved on average of 2.60 (st. dev 1.916), and those who did not 0.79 (st. dev 1.421). The candidates who took the preparation course achieved on average of 2.25 (st. dev 1.934), and those who did not 1.68 (st. dev 1.935). The average points achieved for this problem by the candidates who took the short preparation course (20 hours) was 1.94 (st. dev 1.833) and the average points by the candidates who took the long preparation course (50 hours) was 2.70 (st. dev 2.010). Candidates who both took the preparation classes and passed the entrance examination achieved on average of 2.41 points with st. dev. 1.911 (candidates who took the long preparation course and entrance examination achieved on average of 2.93 points and those who took the short preparation course and passed entrance examination achieved on average of 2.03).

Problem 9 Two sides of the triangle have length 1 and 2 and the angle opposite to the smaller side is $\frac{\pi}{6}$. Calculate the length of the third side and the other two angles.

Goals of the task: *Geometrical conceptual and procedural thinking*

Solution: In this problem candidates are supposed to know Cosine and Sine theorem and their applications, so the points for partial solutions of this problem were awarded as follows:

1- The Law of Sines and The Law of Cosines
2- Two points for third side
3- Two points for the other two angles.

Analysis: The candidates achieved on average of 3.19 points for this problem, with a statistical deviation of 2.293. The candidates who passed the entrance examination achieved on average of 4.58 (st. dev 1.232), and those who did not 0.94 (st. dev 1.760). The candidates who took the preparation course achieved on average of 4.17 (st. dev 1.729), and those who did not 2.53 (st. dev 2.394). The average points achieved for this problem by the candidates who took the short preparation course (20 hours) was 4.04 (st. dev 1.853) and the average points by the candidates who took the long preparation course (50 hours) was 4.36 (st. dev 1.524). Candidates who both took the preparation classes and passed the entrance examination achieved on average of 4.70 points with st. dev. 1.003 (candidates who took the long preparation course and entrance examination achieved on average of 4.72 points and those who took the short preparation course and passed entrance examination achieved on average of 4.68).

Problem 10 Point E is midpoint of the longer side AB of the rectangle $ABCD$. Find the proportion between sides of the rectangle if $\angle DEC = \frac{\pi}{2}$.

Goals of the task: *Geometrical conceptual and procedural thinking*

Solution: In this problem, candidates are supposed to know basic geometric notation (rectangle, angle, etc.) and to construct geometrical image in order to notice the corresponding proportion between sides.
Points for partial solutions of this problem were awarded as follows:

1- One point for correct image
2- Notice similar triangles
3- Notice the symmetry

Analysis: The candidates achieved on average of 1.96 points for this problem, with a statistical deviation of 2.318. The candidates who passed the entrance examination achieved on average of 2.38 (st. dev 2.331), and those who did not 0.55 (st. dev 1.438). The candidates who took the preparation course achieved on average of 2.51 (st. dev 2.344), and those who did not only 1.74 (st. dev 2.232). The average points achieved for this problem by the candidates who took the short preparation course (20 hours) was 2.54 (st. dev 2.369) and the average points by the candidates who took the long preparation course (50 hours) was 2.47 (st. dev 2.330). Candidates who both took the preparation classes and passed the entrance examination achieved on average of 2.75 points with st. dev. 2.341 (candidates who took the long preparation course and entrance examination achieved on average of 2.65 points and those who took the short preparation course and passed entrance examination achieved on average of 2.81).

The results of an analysis of each problem are shown in Figure 1 and Figure 2.

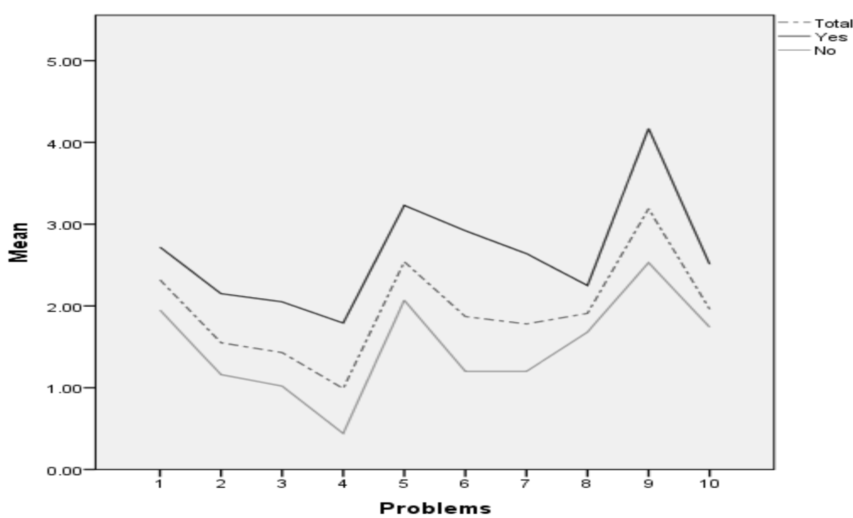

Figure 1.Average points won in mathematics test relative to attendance in preparation course

Discussions

180 (61.9%) candidates successfully passed the entrance examination, while 111 (38.1%) candidates didn't. Out of 117 candidates who took the preparation classes, 102 (87.2%) passed the entrance examination out of which 59 candidates attended the short course and 43 candidates the long course.

The average entrance examination score was 19.45 out of 50 possible, with a standard deviation of 13.371. The maximum score won in the test was 50 (100%). The candidates who took the preparation classes gained on average of 26.39 points with st. dev. 11.937 (30.79 for long course and 28.19 for short course), and those who didn't of 14.79 point with st. dev. 12.426. The candidates who finished Gymnasium/Grammar schools achieved on average of 24.28 points with st. dev. 12.501, Electrical Engineering schools 16.06 points with st. dev. 12.496, Other technical schools 12.18 points, with st. dev. 12.309 and Other schools 13.71 points with st. dev. 10.594.

Using the Kruscal Walis ($x^2 = 44.548, SS = 4, p = .000$) and Mann Whitney U test (U = 4997, z = -7.366, p = 0.000) it is shown a strong statistically significant difference, in the number of points, between the candidates who took preparation classes and those who did not.

Candidates who took the preparation classes are tested in the beginning and at the end of the preparation classes. We obtained the following results: on the first test the average score of the candidates who took the long course was 13.50 points with the statistical deviation 10.298 and the average score those who took the short course was 13.09 points with the statistical deviation 10.543. The average score on the second test was 28.61 points (st .dev. 12.365) for candidates who took the long course and 18.40 points (st. dev. 9.964) for those who took the short course.

The final grade in mathematics of candidates who took the preparation and those who did not is given in table 3.

Table 3. *The final grade in mathematics*

		Took the preparation classes		Total
		Yes	No	
Final grade	2 - Sufficient	5	8	13
	3 - Good	19	41	60
	4 -Very Good	43	78	121
	5- Excellent	50	47	97
Total		117	174	291

It has been shown that there is a large positive correlation between average final grades in mathematics in high school and number of points on the entrance examination (Pearson correlation coefficient was $r = .555$ at the significance level of 0.01).

Using the Kruscal Walis test a statistically significant difference is shown, in the number of points, between the candidates who finished Gymnasium/Grammar schools, Electrical Engineering schools, Other technical schools and Other schools. Using an additional Mann Whitney U test is shown a statistically significant difference, in the number of points, between candidates who finished Gymnasium/Grammar and Electrical Engineering schools (U = 3755, z = -4.673, p=.000), Gymnasium/Grammar and Other technical schools (U = 1939, z = -5.731, p=.000), Gymnasium/Grammar and Other schools (U = 273.5, z = -2.108, p = .035), and Electrical Engineering and Other technical schools (U = 1760, z = -2.076, p =.038).

Conclusion

This paper represents the achievement of undergraduate candidates who took the entrance examination at the Faculty of Electrical Engineering, University of Banja Luka, in June 2015. Depending on the completed high school, the candidates were divided into four categories as follows: Gymnasium/Grammar schools, Electrical Engineering schools, Other technical schools and Other schools. By the comparison with the other candidates, Gymnasium/Grammar graduates had the highest average score in the test and the highest secondary point average in mathematics. A statistically significant difference is shown, in the number of points, between the candidates who took preparation classes and those who did not.

Through the analysis of each problem separately, we see that the candidates who attended preparation classes have significantly higher average scores than those who did not, which is especially evident in problems 6 and 9 (Figure 1). Also, the candidates who attended the longer course (50 hours) have a better average score in problems 1-9, compared to those who attended the shorter course. Only in problem 10, candidates who took the shorter course have in average 2.54 and those who took the longer course have in average 2.47 points (Figure2).

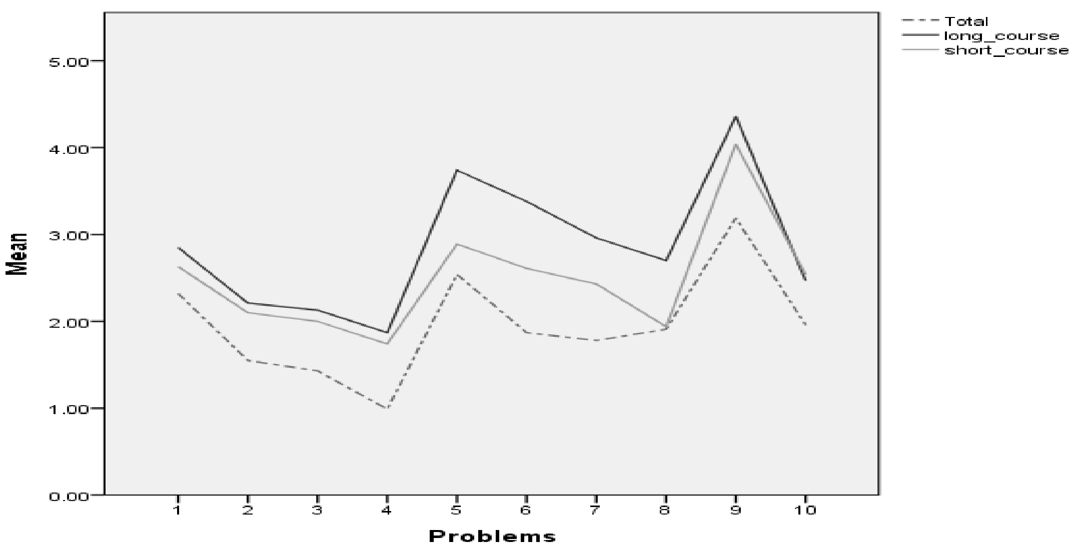

Figure 2. Average points won in mathematics test relative to length of preparation classes

The lowest average score candidates won in the fourth problem only 0.99, while the highest average score won in the ninth problem 3.19. The candidates who took the preparation classes won the lowest average score in the fourth problem 1.79 (1.74 short course, 1.87 long course) and the highest average score in the ninth problem 4.17 (4.04 short course, 4.36 long course).

Out of 117 candidates who took the preparation classes, 102 candidates passed the entrance examination. So, we conclude that the preparation classes are very important for the entrance examination. The preparation course helped some candidates to achieve greater number of points, while to the others it helped to pass the entrance examination.

Also, the length of the course is very important. Out of 47 candidates who attended the long course, only 4 candidates didn't pass the entrance examination. Also, the long variant is very useful for candidates who have a 'not so good' high school knowledge, since by the results of test at the beginning and the end of preparation classes, we saw that the average score of these candidates on the entrance examination (28.68 points) was similar to those in the end of preparation classes (28.61 points). Although they had the lower final high school average in mathematics 4.09 (compared to those who took the short preparation classes), they had a higher score on the entrance exam 28.68 points on average of.

However, following our individual analysis of the problems of the test and given the average number of points gained for the problems, the general conclusion is that we can be content with the candidates' achievement, only for candidates who took the preparation classes. The cognitive factors that have been most widely considered as potential predictors of the faculty mathematics achievement are the entrance examination scores. For example, Troutman [35] and Bridgeman [3] both found significant relationships between SAT (Scholastic Aptitude Test) Math scores and student achievement in college algebra and finite mathematics, respectively, while Torenbeek, Jansen and Hofman [33] found direct positive effects for prior achievement and the pedagogical approach on first-year study success, meaning that students who were more successful in the past, are more successful in the first year at university. Despite contrary findings (Haase and Caffrey [7, 8]) found that high school grades were almost useless as predictors of grades in introductory mathematics courses, and that SAT scores did not predict overall scholastic achievement in community college), the majority of researchers seem to agree that standardized test scores and high school grades are effective predictors of success in university-level mathematics courses. In addition to cognitive and quantitative factors, noncognitive factors have been used successfully to predict grades at the faculty mathematics. Meece [20] et al. found a relationship between student motivation, academic self-concept (a students' personal opinion toward her or his academic skills), and achievement in introductory math courses, and an associated relationship between initial achievement and downstream persistence in more advanced math courses.

Acknowledgement: The authors are grateful to anonymous referees and to the Editor for helpful comments and suggestions which improved the paper.

References

[1] Bogoslavov, V. (2003). *Zbirka rešenih zadataka iz matematike 1* [Solved problems in Mathematics 1]. Beograd, Srbija: Zavod za udžbenik i nastavna sredstva. (In Serbian)

[2] Bogoslavov, V. (2011). *Zbirka rešenih zadataka iz matematike 2* [Solved problems in Mathematics 2]. Beograd, Srbija: Zavod za udžbenike i nastavna sredstva. (In Serbian)

[3] Bridgeman, B. (1982). Comparative validity of the College Board Scholastic Aptitude Test – Mathematics and the Descriptive Tests of Mathematical Skills for predicting performance in college mathematics courses. *Educational and Psychological Measurement,* **42** (1): 361-366.

[4] Delić, M. (2005). *Zbirka riješenih zadataka sa prijemnih ispita* [Solved problems from the university entrance examinations]. Banja Luka, Bosna i Hercegovina: ETF Banja Luka. (In Serbian)

[5] Gill, P. (1999a). The physics/maths problem again. *Physics Education,* **34** (2): 83- 87.

[6] Gill, P. (1999b). Aspects of undergraduate engineering students' understanding of mathematics. *International Journal of Mathematical Education in Science and Technology,* **30** (4): 557-563.

[7] Haase, M., and Caffrey, P. (1983a). *Assessment Procedures, Fall 1982 and Spring 1983 Semi-Annual research Report, Part I*. Sacramento, CA: Sacramento City College.

[8] Haase, M., and Caffrey, P. (1983b). *Assessment and Placement at Sacramento City College*. Sacramento, CA: Sacramento City College.

[9] Henningsen, M., and Stein, M. K. (1997). Mathematical Tasks and Student Cognition: Classroom Based Factors That Support and Inhibit High-Level Mathematical Thinking and Reasoning. *Journal for Research in Mathematics Education,* **28** (5), 524-549,

[10] Jackman, S., Goldfinch, J., and Searl, J. (2001). The effectiveness of coursework assessment in mathematics service courses – studies at two universities. *International Journal of Mathematical Education in Science and Technology,* **32** (2): 175-187.

[11] Kadijević, Đ., Marinković, B., and Brkić, P. (2004). How successful is mathematics education in Serbia according to the TIMSS 2003 primary results and what should be done to improve it?. *The Teaching of Mathematics,* **7** (1): 53-60.

[12] Kaiser, G., and Willander, T. (2005). Development of mathematical literacy: results of an empirical study, *Teaching mathematics and its applications*. **24** (2-3): 48-60.

[13] Kaur, B. (2010). A Study of Mathematical Tasks from Three Classrooms in Singapore. In Y. Shimizu, B. Kaur, R. Huang & D. Clarke (Eds.), *Mathematical tasks in classrooms around the world* (p p. 15-33), Sense Publishers, Rotterdam.

[14] Kilpatrick, J., Swafford, J., and Findell, B. (2001). *Adding it up: Helping children learn mathematics.* Washington, DC: National Academy Press.

[15] Koh, K. H. and Lee, A. N. (2004). *Technical report: Manual for scoring teacher assignments or assessment tasks*. Singapore: National Institute of Education, Centre for Research in Pedagogy and Practice.

[16] Kohanova, I. (2012). Analysis of University Entrance Test from mathematics, *Acta Didactica Universitatis Comenianae Mathematics*, **12**: 31-46

[17] Kosić-Jeremić, S. (2012). Teaching mathematics at faculties of engineering in Bosnia and Herzegovina viewed through teaching and solving extremal problems – a case study. *IMVI Open Mathematical Education Notes,* **2**: 39-50.

[18] Kosić-Jeremić, S., and Preradović, Lj. (2014). Achievement in university entrance examination relative to attendance in preparation classes and type of secondary school completed: a case study of geodesy undergraduate candidates. *International Journal of Education and Research,* **2** (9): 59-70.

[19] Lawson, D. (2003). Changes in student entry competencies 1991-2001. *Teaching Mathematics and its Applications*, **22** (4): 171-175.

[20] Meece, J.L., Parsons, J.E., Kaczala, C.M., Goff, S.B., and Futterman, R. (1982). Sex differences in math achievement: Toward a model of academic choice. *Psychological Bulletin,* **91**: 324-348.

[21] Ognjanović, S. (2012). *Rešeni zadaci sa prijemnih ispita* [Solved problems from the university entrance examinations]. Beograd, Srbija:Krug. (In Serbian)

[22] Othman, H., Asshaari, I., Tawil, N.M., Ismail, N.A., Nopiah, Z.M., and Zaharim, A. (2012). Analysis on Mathematics Fundamental Knowledge for Mathematics Engineering Courses based on a Comparative Study of Students' Entry Performance. *Procedia - Social and Behavioral Sciences,* **60** : 365 - 371.

[23] Pyle, I. (2001). Mathematics in school. *Engineering Science and Education Journal,* **10** (5): 170-171.

[24] Romano, D.A., and Vinčić, M. (2011). An essay on mathematical education in the Republic of Srpska, Bosnia and Herzegovina. *IMVI Open Mathematical Education Notes,* **1**: 19-28.

[25] Romano, D.A. (2013). Резултати пријемног испита на Машинском факултету у Бањој Луци, одржаног 02.07.2012.[Results of the examination test at the Faculty of Mechanical Engineering happened on 2nd July 2012]. *MAT-KOL*, **19** (2): 15-19. (In Serbian)

[26] Romano, D.A. (2014). Анализа резултата пријемног теста из математике на Машинском факултету у Бањој Луци одржаног 01.07.2013. [Analyzing of the examination test in Mathematics at the Faculty of Mechanical Engineering happened on 1st July 2013]. *IMO,* VI, **10**: 5-24. (In Serbian)

[27] Romano, D.A. (2014a). The use of mathematical tasks design to establish development of students' mathematical thinking by an admission exam at Faculty of Mechanical Engineering of the Banja Luka University, *IMVI Open Mathematical Education Notes,* **4**: 19-29 .

[28] Rozov, N.H. (2004). The problem of arrangement of new notions and objects in the school course of mathematics. *The Teaching of Mathematics,* **7** (1): 1-9.

[29] Sazhin, S.S. (1998). Teaching mathematics to engineering students, *International Journal of Engineering Education*, **14** (2): 145-152.

[30] Shafer, M. C., and Foster, S. (1997). The changing face of assessment. *Principled Practice in*

Mathematics and Science Education, **1** (2): 1-8.

[31] Sullivan, P., Clarke, D. M., Clarke, B. A., and O'Shea, H. (2009). Exploring the relationship between tasks, teacher actions, and student learning. In M. Tzekaki, M. Kaldrimidou, & H. Sakonidis (Eds.), In search of theories in mathematics education. *Proceedings of the 33rd Conference of the International Group of Psychology of Mathematics Education*, (Vol. 5, pp. 185-192). Thessaloniki, Greece: PME.

[32] Tang, H.E., Voon, L.L., and Julaihi, N.H. (2009). A case study of 'High-Failure Rate' mathematics courses and its' contributing factors on UiTM Sarawak diploma students. *Paper presented at the Conference on Scientific & Social Research,* 14-15 March 2009. Available on http://versys.uitm.edu.my/prisma/view/viewPdf.php?pid=2763

[33] Torenbeek, M., Jansen, E.P.W.A., and Hofman, W.H.A. (2011). Predicting first-year achievement by pedagogy and skill development in the first weeks at university. *Teaching in Higher Education,* **16** (6): 655-668.

[34] Travers, K.J., and Westbury, I. (1989). *The IEA study of mathematics I: international analysis of mathematics curricula*. Oxford: Pergamum Press.

[35] Troutman, J. (1978). Cognitive predictors of final grades in finite mathematics. *Educational and Psychological Measurement,* **38** (2)**:** 401-404.

Received by editors at 11.10.2015; revised version at 25.12.2015 and 02.01.2016.
Available online at 11.01.2016