Relationship between enrolment criteria and first-year students’ study-success

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Abstract— The paper discusses the usability of enrolment points achieved based on the results of State Matura exams and points achieved based on high school grades as predictors of study success measured by number of ECTS credits achieved one year after enrolment for students at two faculties. The results of the multivariate analysis indicate that points achieved based on high school grades are a statistically significant predictor for both faculties and points achieved based on the results of State Matura exams for one of the two faculties. Prediction quality of the multivariate model for the analyzed aspect of study success, measured by multiple R-squared, is low to medium.

Keywords- ECTS credits, high school grades, multiple regression, State Matura exams

I. INTRODUCTION

The state graduation exam (State Matura exams) in Croatia is a standardized set of external final exams that determines the level of achieved student’s knowledge and competences at the end of the 4-year secondary education. There are mandatory and elective State Matura exams. Mandatory exams are the Croatian language, mathematics and a foreign language and they can be taken at two levels: higher (A) and basic (B). All other State Matura exams can be taken at one level. Students of grammar schools are obliged to take State Matura in order to finish their secondary education in Croatia. Students of vocational and art schools are also eligible for State Matura exams, provided they have completed a 4-year program and that their secondary education ends with the creation and defense of the final paper [1].

Exams are the same for all candidates. They are taken at the same time and in the same tests conditions. Even though the State Matura is considered as a valid, reliable, objective and fair evaluation method of school achievements, there are some thoughts about the unfairness of such exams, because not all candidates have equal opportunities to have a good result considering that they come from different school programs [2].

The requirement for entry into higher education is to pass the State Matura. Each higher education institution has certain requirements for enrolment into its study programs. Majority of higher education institutions use the results of State Matura and the average success during secondary education instead of the entrance exam. Some of them are also checking specific skills and talents in the selection process.

The adoption of the Bologna Declaration by Education Ministers from 29 European countries in 1999 marked a turning point in the development of higher education in Europe. Its main goal was to establish a greater compatibility and comparability of higher education systems, to enhance the attractiveness and competitiveness of Europe’s higher education systems and greater employability of higher education European graduates [3].

One of the main aims of the methodological transformation of the higher education system, according to the Bologna Process, is the transformation in the measurement of the students’ work to pass subjects in ECTS (European Credit Transfer System) [4].

ECTS is a learner-centered system for credit accumulation and transfer directed toward the student and students’ workload which is needed to achieve the objectives of the study program specified in the learning outcomes. The aim of introducing this system is to facilitate planning, implementation, evaluation and recognition of qualifications and units of learning, as well as student mobility [5]. 60 ECTS credits is the amount of student workload in a formal learning context in one year of full time study and is associated with learning outcomes. In most cases, student workload ranges from 1500 to 1800 hours for an academic year, whereby one ECTS credit represents 25 to 30 hours of student’s workload.

Introduction section provided basic information on State Matura and ECTS credits as research domain. The next section introduces the research question and presents some related work done on the research of study success. The final section outlines data, methodology and results of the analysis. The main findings are then summarised in the Conclusion.

II. RELATED WORK

After the investigation of papers published in available proceedings of conferences and journals, few of them that are related to investigation of study success at university level are selected mostly focusing in Croatian context. The papers have different definitions of success, predictors of success and methods used to analyze success. None of the papers discusses the usability of requirements for enrolment in study programs: points achieved based on results of State Matura exams and points achieved based on high school grades, as predictors of one of the aspects of success: the number of ECTS credits achieved after one year of study. The main research question of
this paper is to investigate the mentioned usability in Croatian context.

One of the papers [6] in this field of research aims to investigate whether the introduction of national Matura has resulted in enrolment of higher quality students, who achieved higher average grade, better pass rate and completion within the stipulated duration of studies, than the students enrolled prior to introduction of national Matura. That research was conducted using the available data on the 2009/2010 generation of full-time students of undergraduate university studies, as the last generation of students who were enrolled in the first year of study without State Matura, and the 2010/2011 generation, as the first generation of undergraduate university studies that was required to pass the Matura exam and was enrolled in the first year of study based on the results of the Matriculation exam. The main findings were that there was no increase in average grade among students that have passed the Matura exams in relation to students enrolled a year earlier. But the students of the 2010 generation are achieving better exam pass rates than the students of the 2009 generation.

Different methods are used for prediction of academic achievements. For example, in research [7] classification trees and neural networks are used to make a model for predictions of passing the course Mathematics 1. Course of Mathematics 1 is taught at the Polytechnic of Varazdin in all technical studies in the winter semester of the first year of study. Data for creating models for predicting the passing of the Course were collected through a survey research conducted in academic year 2010/2011 with students of that course. After elimination of incompletely filled-out questionnaires, representative sample consisted of 131 students. Based on the 12 input variables and one output variable, a model of classification and prediction of passing the course was made. Classification trees gave a higher classification accuracy of neural networks and it seems as better solution for creating models for passing the course.

Research question of another paper about the discussed topic was whether the same admissions data can be used to predict first-semester success [8]. The predictors for enrolment and persistence may not be the same for different-size colleges or universities considering that, compared to their larger-sized and better-endowed counterparts, small private colleges may lack adequate laboratory or sports facilities, they have fewer course offerings, meagre marketing budgets, and fewer feeder high school networks that could affect college choice. Authors of that research concluded that the predictors of first-semester success for the small, private college studied here are high school GPA (grade point average), an offer of two scholarships, being a second choice school, and indecision on major at admission.

In [9] authors investigate relationship between scores in State Matura exams in Mathematics, Croatian language, high school grades and success in some mathematical courses in the undergraduate study of Information and Business Systems at the University of Zagreb, Faculty of Organization and Informatics. The main method used for prediction of success in mathematical courses in the paper is logistic regression. Authors identified significant prediction power of high school grade point average on pass rates in Mathematics 1 and 2. There is a positive correlation between the results of State Matura exam in Mathematics and pass rates in Mathematics 1 and 2. Results of Croatian language State Matura exam are the least important for passing Mathematics 1 and 2.

In paper [10] authors examined effects of 30 variables upon the dependent variable Student success. They stated two hypotheses. H1: Previous education, regular active class attendance, lectures and motivation for the studies show discriminant validity in the prediction of academic performance (studying success) and H2: Student’s gender does not show discriminant validity in the prediction of academic performance. Authors claimed that H1 was confirmed and H2 should be considered undecided, since gender contributes to discrimination between more successful students and less successful ones to a certain extent. Research method used in the paper was discriminant analysis. Data were collected using questionnaire among students at Faculty of Organization and Informatics, University of Zagreb.

There is a wide range of methods that can be used in learning analytics, especially for analysis of factors of study success at university level. Paper [11] describes how discriminant analysis, neural networks, random forests and decision trees can be used to predict students’ academic success.

III. DATA AND METHODOLOGY

The research included a total of 512 full-time students at the study program Information and Business Systems (IBS) at the Faculty of Organization and Informatics, University of Zagreb enrolled in the first year study for the first time. Out of this number, 254 students were enrolled in academic year 2011/2012 and 258 students were enrolled in academic year 2012/2013.

The total number of full-time students enrolled in the first year study for the first time in undergraduate study at Faculty of Economics (EFOS), University of Osijek was 505, of those 299 students in academic year 2012/2013 and 206 students in academic year 2013/2014.

Examined variables in this analysis are points achieved based on high school grades (School), points obtained at the State Matura exams (Matura) and ECTS credits (ECTS) achieved in period of one year after enrolment. Points from high school are based on high school grades and the highest possible points a student could have is 350 points for IBS program, and 200 points for EFOS. State Matura points are collected from all exams that student took and passed in Croatian language, Mathematics and Informatics and student could achieve maximum of 650 points at IBS, and 800 for EFOS. A year after enrolment student can achieve 60 ECTS credits or more, based on the number of enrolled courses. The requirements for the undergraduate study program IBS at the Faculty of Organization and Informatics are higher level of Mathematics, higher or basic level of Croatian language and Informatics is non obligatory. Requirements for enrolment on the study of Economics are basic level of Mathematics, basic level of Croatian language, basic level of foreign language and Politics and Economics. This research tries to bring some insight into success based on number of ECTS credits as one of
the success measures and enrolment requirements defined by two faculties, for the years with available data.

Prediction of the first year study success is done using multiple linear regression. Multiple linear regression is generally used for modeling relationship between two or more explanatory variables and a response variable by fitting a linear equation to observed data. The mentioned method is used to model relationship between response variable number of ECTS credits and explanatory variables points achieved based on high school grades and points achieved based on the results of State Matura exams.

Computation is done in R Studio, a user interface for R programming language and MS Excel 2010.

### A. Analysis for Information and Business Systems

Table I contains the descriptive statistics calculated for the above defined variables for the students enrolled in the study at the Faculty of Organization and Informatics. The average points achieved at high school as well as average points from State Matura in academic year 2012/2013 were slightly higher than in academic year 2011/2012. According to the results of Welch Two Sample t-test, students enrolled in academic year 2012/2013 had 258.30 points from high school or less, while the remaining 50% of students had 285.30 points or more. In academic year 2012/2013 median of points from high school was 270.20 points. Median of points at the State Matura exams determined in academic year 2012/2013 was higher than in academic year 2011/2012. Observing academic year 2011/2012, the first quartile shows that a quarter of the students had 232.60 points from high school or less, while the third quartile shows that a quarter of the students had 290.30 points or more. Quartiles of the points from Matura exams were slightly lower than quartiles of the points from high school. Situation is similar for the academic year 2012/2013. The average number of ECTS credits in academic year 2012/2013 was higher than the average number of ECTS credits in academic year 2011/2012. Described by median, the difference was 5.50 ECTS credits. In academic year 2011/2012 half of the students achieved between 6.00 and 55.75 ECTS credits, while in academic year 2012/2013 half of the students achieved between 7.25 and 56 ECTS credits. Therefore, the interquartile determined for students in academic year 2011/2012 was by 1 ECTS credit higher than the value calculated for interquartile in academic year 2012/2013. The present descriptive statistical indicators for ECTS credits are also visible in Fig. 1.

To determine if there is a statistically significant difference of means in achieved ECTS credits between two groups of students, students enrolled in academic years 2011/2012 and students enrolled in 2012/2013, Welch Two Sample t-test is applied. The following results are obtained: t value of -0.91, on df=599.99 and p-value=0.36, 95 percent confidence interval of the means difference is [-5.99, 2.20].

According to the results of Welch Two Sample t-test, the difference between achieved ECTS of two groups of students is not statistically significant.

### Table I. Descriptive statistics of students’ points achieved in high school and at the Faculty (IBS)

<table>
<thead>
<tr>
<th>IBS</th>
<th>2011/2012</th>
<th>2012/2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st Q.</td>
<td>Median</td>
</tr>
<tr>
<td>School</td>
<td>232.60</td>
<td>258.30</td>
</tr>
<tr>
<td>Matura</td>
<td>247.90</td>
<td>233.40</td>
</tr>
<tr>
<td>ECTS</td>
<td>6.00</td>
<td>32.97</td>
</tr>
</tbody>
</table>

Figure 1. ECTS credits achieved in acad. year (IBS)

Table II presents Pearson’s correlation coefficients among variables: points achieved based on high school grades, points obtained at the State Matura exams and ECTS credits. Coefficients indicate medium correlation among all observed variables.

Graphical representation of those results is given in Fig. 2. It presents Scatterplot matrix in which observed variables are written in a main diagonal of the matrix. In the lower triangle of this matrix variables are plotted with column variable as the X-axis, and row variable as Y-axis. Correlation coefficients are shown in the upper triangle of Scatterplot matrix.

### Table II. Correlation among observed variables (IBS)

<table>
<thead>
<tr>
<th>IBS</th>
<th>School</th>
<th>Matura</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>1</td>
<td>0.36</td>
<td>0.47</td>
</tr>
<tr>
<td>Matura</td>
<td>0.36</td>
<td>1</td>
<td>0.47</td>
</tr>
<tr>
<td>ECTS</td>
<td>0.47</td>
<td>0.47</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 2. Scatterplot matrix of observed variables (IBS)
Prediction of the first year study success is done using multiple regression. Multiple regression is used since Scatterplots indicate linear relationships of variable ECTS with variable Matura points and variable School points. Multiple regression equation

$$\text{ECTS} = \beta_0 + \beta_1 \text{SCHOOL} + \beta_2 \text{MATURA}$$  \hspace{1cm} (1)

Basic indicators of multiple regression achieved by least squared error estimation are given in Table III.

| Variables | Coeff. | Std. Err | t value | Pr>|t| |
|-----------|--------|----------|---------|-------|
| Intercept ($\beta_0$) | 45.03 | 5.80 | -7.76 | 4.58e-14 |
| School ($\beta_1$) | 0.20 | 0.02 | 8.83 | 5e-16 |
| Matura ($\beta_2$) | 0.09 | 0.01 | 8.99 | 5e-16 |

Both high school grades and Matura exams are statistically significant predictors of success. Each additional point achieved based on high school grades, keeping Matura exams points constant, predicts 0.2 more ECTS credits achieved. Each additional point achieved based on Matura exams results, holding high school points constant, predicts 0.09 more ECTS credits achieved. R-squared is the percentage of the response variable variation that is explained by a linear model. Multiple R-squared for the model is 0.3261 and adjusted R-squared is 0.80. Points from high school or less, while a quarter of the students had 138.80 points from high school or less, while a quarter of the students had 171.60 points or more. In academic year 2013/2014 those numbers are slightly higher. First quartile of the points from Matura exams in academic year 2012/2013 is barely higher (by 2.10 points) than first quartile of the points from Matura exams in academic year 2013/2014, while third quartile of the points from Matura exams in academic year 2012/2013 is slightly lower (by 10.50 points) than third quartile of the points from Matura exams in academic year 2013/2014.

The average number of ECTS credits in academic year 2012/2013 and in academic year 2011/2012 is almost equal, while the median in academic year 2012/2013 is by 2 ECTS credits lower than in academic year 2013/2014. First quartile shows that a quarter of the students had 46.00 ECTS credits or less in academic year 2012/2013 and 47.25 ECTS credits or less in academic year 2013/2014. In both academic years, a quarter of the students had maximum ECTS credits.

Welch Two Sample t-test for determination of a statistically significant difference of means in achieved ECTS credits between two groups of students, students enrolled in academic years 2012/2013 and students enrolled in 2013/2014 gave the following results: t value = -0.37, on df=454.85 and p-value=0.71. 95 percent confidence interval of the means difference is [-3.40, 2.31]. The difference between achieved ECTS of two groups of students is, according to the Welch Two Sample t-test, not statistically significant.

It is obvious from Table IV that the average points achieved at high school for students who enrolled in Faculty of Economics (EFOS) in academic year 2012/2013 and in academic year 2013/2014 are almost identical, while the average points from State Matura in both academic years are equal. Median of points from high school was 428.30 points in academic year 2012/2013 and 429.30 points in academic year 2013/2014. In academic year 2013/2014 median of points from Matura exams was only by 1 point bigger than in academic year 2012/2013. In academic year 2012/2013 a quarter of the students had 138.80 points from high school or less, while a quarter of the students had 171.60 points or more. In academic year 2013/2014 those numbers are slightly higher. First quartile of the points from Matura exams in academic year 2012/2013 is barely higher (by 2.10 points) than first quartile of the points from Matura exams in academic year 2013/2014, while third quartile of the points from Matura exams in academic year 2012/2013 is slightly lower (by 10.50 points) than third quartile of the points from Matura exams in academic year 2013/2014.

Table III. Descriptive statistics of students’ points achieved in high school and at the Faculty (EFOS)

<table>
<thead>
<tr>
<th>EFOS</th>
<th>2012/2013</th>
<th>2013/2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st Q.</td>
<td>Median</td>
</tr>
<tr>
<td>School</td>
<td>138.80</td>
<td>156.40</td>
</tr>
<tr>
<td>Matura</td>
<td>399.90</td>
<td>428.30</td>
</tr>
<tr>
<td>ECTS</td>
<td>46.00</td>
<td>55.00</td>
</tr>
</tbody>
</table>

The difference between achieved ECTS of two groups of students is, according to the Welch Two Sample t-test, not statistically significant.

In Fig. 3 descriptive statistical indicators for ECTS credits are presented.

Graphical representation of those results is given in Scatterplot matrix in Fig. 4.
Prediction of the first year study success is, as before, done using multiple regression with the multiple regression equation (1).

Basic indicators of multiple regression are given in Table VI.

Variable points achieved based on high school grades are statistically significant predictor of success. Each additional point achieved based on high school grades, holding Matura exam points constant, predicts 0.246 more ECTS credits achieved. Matura exams result is not statistically significant variable. Because multiple R-squared for the model is only 0.100, model is not very successful but indicates that Matura exams points can't be used for such predictions. There are other variables that have to be identified for prediction.

IV. CONCLUSION AND FURTHER RESEARCH

The main research goal of this paper is examination of one aspect of success in the first year of study for students at two faculties: Faculty of Organization and Informatics (FOI) and Faculty of Economics (EFOS). The aspect of success was defined as number of ECTS credits achieved in period of the first year after enrolment. For the purpose, it is investigated whether variables points achieved based on high school grades and points achieved based on State Matura exams can be used as predictors of the aspect of success in two case studies: FOI and EFOS. Only those three variables for the two faculties are considered due to data availability. In our cases, the conclusion is that high school grades are a better predictor for the aspect than the State Matura exams. In previous research, for example [8] and [9], authors also identified significant prediction power of high school grades for study success in some particular courses or in whole first-year study program. Habits of continuous work seem to be more important for study success than one time results on Matura exams. Presented models did not have high predictive power so other variables are proposed for investigation for prediction purposes, e.g. motivation of students, their socioeconomic status, schools students are coming from etc. complementary to this research and other study success researches.

REFERENCES