The Influence of Secondary School Education on the Success of Informatics Education in University

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***Abstract*–The suppositions and dimensions of the influence of secondary school education on the quality and effects of informatics education in University are manifold. The influence of secondary school education can be perceived through two basic dimensions: 1) the general influence dimension of a specific secondary school, and 2) the dimension of the influence of computer and related classes, which students were exposed to during secondary school. The aforementioned dimensions of influence can be analyzed by defining key factors of general secondary school education, and the factors of informatics education in secondary school, which are significant for the quality and effects in higher computer science education. The defined basic and exactly measurable criteria of the influence of secondary school education on the students' informatics education in college are the criterion of the number of school years during which information science classes were taken, as well as the criterion of secondary school orientation (course), among which those students were selected, who graduated from economics secondary schools and gymnasium (comprehensive) secondary schools.**

***Index Terms*–education, informatics, secondary school, success, university**

I. INTRODUCTION

The use of a new generation of information and communication technologies based on the world-wide web, electronic mail, learning objects, discussion groups and user-oriented tools and programs (Word, PowerPoint, Excel, Access) creates the predispositions for the transformation of the organization and implementation of the teaching curriculum, which increases the quality of informatics education. The new generation of information and communication technologies also represents a catalyst for a change of the paradigm of the entire teaching process, including all segments and dimensions of teaching. This implies that, simultaneously with a shift in the organization, implementation and effect of teaching to a higher level of quality, all important segments of the teaching process are systematically and ingeniously connected.

In such a context, this paper reviews the criteria of influences of secondary school education on the success of informatics education in college, on the example of Computer Science courses, which students have in their first semester curriculum. The factors of general secondary school education and computer education which are essential for a successful informatics education and training are systematized, as well as criteria indicating the realization of these factors. It should be noted that the neither Information Science grades nor general grades were analyzed as criteria of influence of secondary school education on informatics education in college. Namely, secondary school grading criteria are not systematized; rather, they differ from school to school. For example, students who have graduated from the hotel and tourism industry secondary school, and who used to have excellent grades in information science, often demonstrate a weaker foreknowledge than students who have graduated from the gymnasium (comprehensive) secondary school.

As a measurable criterion of informatics education in secondary school, the number of school years was analyzed, during which the students had Information Science in their curriculum. Also, criteria which indicate the quality of general secondary school education were also taken into account, such as the type of secondary school, professional orientation, size of high school expressed in the number of departments, teachers and students, as well as the secondary school's history and tradition. The problem with all of the aforementioned criteria is that they are not readily measurable. For example, all gymnasium courses share the same curriculum, and the size and tradition of the schools are relative and difficult to measure. As a measurable criterion of general education, we have defined the criterion of the secondary school and orientation/course from which the student has graduated, and which demonstrates the breadth and compatibility of the curriculum of secondary school education with college curriculums.

Based on the aforementioned items, two groups of students were formed – one group includes students who had Information Sciences as part of their curriculum during all four years of secondary education, while the other group includes all those who had three years of informatics education, and who have graduated from the gymnasium or economics. The hypothesis of this paper is that secondary school education has significant influence on the success on informatics education in college. The hypothesis is proven through the testing of the arithmetic mean value of Information Science grades between the two groups of students.

II. GENERAL INFLUENCE FACTORS OF SECONDARY SCHOOL EDUCATION

The following factors [6] can be mentioned as factors of general influence at the system and program level of a specific secondary school in regard of computer science education:

1. Quality of education

(systematic improvement and ensuring the educational quality level, the level of responsibility of all participants in the educational system, the monitoring and systematical analysis of the reasons behind successes and failures; a valid, reliable, impartial and fair evaluation of the students' scholarly achievements).

2. Result-oriented education

(orientation towards knowledge and competence which the students have acquired by the point they graduate from secondary school; a clear definition of education goals – results of learning and teaching).

3. Setting transparent educational standards

(setting transparent standards for the evaluation of the students' achievements at the end of secondary school education, a clear definition of key outgoing competences for the acquisition of qualifications in professional education, adapted to the requirements of the economy and the labor market, achieving a state in which the secondary school certificates are transparent, recognizable and comparable documents in the domestic and European labor markets).

4. Framework of merit

(achieving that knowledge and competence, as basic points of reference and important goals of education, become clear, measurable and comparable values; adopting a system of values according to which one's effort and conscientious learning and work can achieve success in education and life; giving dignity to knowledge and education).

5. Education vertical

(enabling a less complex, more fair and transparent selection for the enrollment in institutions of higher education, a better connection between secondary education and higher education, enabling a better preparedness of future students for their studies, the ability of self-regulated learning, time spent learning, knowing the techniques of learning and temporal organization, perseverance, motivation for achievement, discipline, conscience...)

III. FACTORS OF COMPUTER SCIENCE EDUCATION IN SECONDARY SCHOOL

Information technology is delivering an extraordinary improvement to all areas of human activities, it is opening up the possibilities of improving the quality and the quantity of production and the standard of living, and it is generally broadening the scope of new opportunities in all areas of life [8; 12]. Achieving the goals of strategically oriented information science education is a key factor in mastering the relevant strategic knowledge and skills. In the aim of achieving more qualitative and continuous information science education, it is necessary to define educational goals. The most important teaching goals in information science education can be defined as the following [7]; [11; II-3]:

- a clear conception of the possibilities offered by computers and computer applications for a given problem area,
- the ability to accept the information science thinking process and the understanding of computer logic in problem analysis,
- an understanding of the logic and the advantages of this new way of solving tasks by the use of modern information technologies,
- the ability to apply knowledge gained at university to the development and the use of applications in dealing with strategic problems,
- the ability to create, sustain and develop one's own user programs (applications) for performing given work tasks,
- a positive attitude about the introduction of information technologies to solving strategic problems and a positive influence on the work environment (for example, groups, teams, management),
- to master the use of a computer and all of its units,
- to master information technologies synergy
- to gain basic information science literacy to the level of solving complex problems in non-structured situations, with the application of information technology,
- to gain and to develop logic and creative abilities in selecting and writing programs in solving non-structured problems, given for a specific problem situation,
- to get introduced to the goals of the society and the dimensions of informatization and information resource management,
- to get introduced to the possibilities and the advantages of network communication,
- to develop the correct relationship towards the use and the protection of programs and data,
- to observe the role of team work in information science.

The achievement of goals in strategically oriented information science education is a fundamental factor in mastering relevant strategic knowledge and skills on a university level. The benefit of such education and achievement of skills in understanding and using information technology can be seen in the example of a transition from a traditional office employee to an employee that uses information technology. Quality information technology education is a fundamental factor in achieving presumptions for such a transition.

IV. PURPOSE AND PROPERTIES OF THE RESEARCH OF THE INFLUENCE OF SECONDARY SCHOOL EDUCATION ON THE SUCCESS OF COMPUTER SCIENCE EDUCATION IN COLLEGE

With the aid of survey questionnaires, the research attempts to establish the influence of secondary school on

the success of computer science education in college. The research was conducted on a sample of 72 students in their freshman year at the Faculty of Economics in Rijeka. The research collects data on respective secondary schools from which they graduated, the type of secondary school, the professional orientation/course, and the number of school years during which Information Science was included in their curriculum.

The research demonstrates that 60% of the students graduated from a general secondary school (gymnasium), 28% of students graduated from Economics, while 12% graduated from other orientations/courses (language, sports, electrotechnics, tourism...).

A much greater variety was noticed in the analysis of the secondary schools the students have graduated from, which is illustrated in table 1. This table displays an overview of secondary schools, the number of students (included in the survey) from the cited secondary schools, as well as the average Information Science grade that the students have achieved at the end of the first semester.

TABLE I.
AN OVERVIEW OF THE SECONDARY SCHOOLS THE STUDENTS HAVE GRADUATED FROM

Srednja škola	Broj studenata	Srednja ocjena
Ekonomska škola Mije Mirkovića Rijeka	12	3
Srednja škola Pavla Rittera Vitezovića Senj	4	2,5
Gimnazija Pazin	3	2,7
Prva gimnazija Varaždin	3	4
Prva riječka hrvatska gimnazija Rijeka	3	1,7
Prva sušačka hrvatska gimnazija	3	4,7
Srednja škola Mate Balote Poreč	3	4,3
Ekonomsko-turistička škola Karlovac	2	1,5
Gimnazija	2	2
Gimnazija Andrije Mohorovičića Rijeka	2	3,5
Gimnazija Bjelovar	2	1,5
Gimnazija Eugena Kumičića Opatija	2	2
Gimnazija Karlovac	2	2
Gimnazija Zadar	2	1
Hotelijersko - turistička Opatija	2	2,5
Salezijanska klasična gimnazija Rijeka	2	2
Srednja škola Vladimir Gortan Buje	2	4
Srednja škola Zvane Črnje Rovinj	2	3
Ekonomska i trgovačka škola Čakovec	1	4
Ekonomska Otočac	1	2
Ekonomska Slunj	1	2
Ekonomska škola Daruvar	1	4
Ekonomska škola Slavonski Brod	1	4
Elektrostrojarska Varaždin	1	2
Gimnazija Čakovec	1	4
Gimnazija Duga Resa	1	2
Gimnazija Koprivnica	1	1
Gimnazija Korčula	1	4
Gimnazija Pula	1	1
Srednja škola "Hrvatski kralj Zvonimir" Krk	1	1
Srednja škola Ambroza Haračića Mali Lošinj	1	4
Srednja škola Delnice	1	5
Srednja škola Duga Resa	1	1
Srednja škola Mate Blažine Labin	1	1
Srednja škola Omiš	1	1
Srednja škola Prelog	1	1
Srednja škola Vladimir Nazor Čabar	1	2

In the research of the significance of secondary school education, the method of testing the significance of the differences between arithmetical means was used while processing the questionnaires. Two groups were formed (group A and group B) according to the criterion of the number of school years during which Information Science was included in the students' secondary school curriculum. Also, the Type criterion was introduced, which can be observed in table 2., signifying the type of secondary school (gymnasium, economics, professional, combined...). In table 2., label 1 in the Type column designates the gymnasium, economics school, or combined school, predominantly containing economics and gymnasium orientations. Label 2 in the Type column designates secondary schools with predominantly professional orientation. The groups can be observed in table 2. Group A contains students who had four years of Information Science in their curriculums, and those who had at least three years of Information Science and who graduated from an economics secondary school or a gymnasium, i.e. those who have graduated from an economics or gymnasium orientation and whose secondary school type is labeled as type 1. The hypothesis is that the success of students from group A will be significantly different from the success of the students from group B.

The aforementioned criteria represent the presumptions of the realization of factors mentioned in previous sections, i.e. the presumptions of the realization of factors of the general influence of secondary school education, and the presumptions of the realization of factors of computer science education. For example, the number of school years during which Information Science was a part of the students' curriculum is an exact and measurable criterion which can – up to a certain point – demonstrate the influence of secondary education on the success of computer studies education. The analyzed factors also include the secondary school's tradition, the secondary school's size, the number of teachers and departments, all of which helps to demonstrate the general influence of secondary school education on computer science education in college.

In the classification of students, based on the aforementioned criteria of secondary school education in the function of the success of computer science education in college, it should be mentioned that there are certain criteria which cannot be exactly defined, such as individual potential, and students' affinities, quality, working method, pedagogical approach, creativity and innovativeness of the teachers, the relation and synergy of the students and the teachers...

V. RESULTS OF THE RESEARCH

Table 2. displays data on the students' orientation in secondary school, the number of school years during which Information Science was part of their secondary school curriculum, their final Information Science grades in college, and the grades achieved in preliminary exams I and II. The bold line between line 36 and 37, i.e. between enumerations 35 and 36, designates the limit

between groups A and B. The table illustrates that the students were classified into groups based on the criteria mentioned in the previous section, along with the description of the purpose and properties of the research.

In the analysis of the results, and with the aid of the T-Test, we conducted a test of the hypothesis of the significance of differences of arithmetical means between group A and group B [3]. The basic hypothesis of this paper is that there is a significant difference between students from group A, whose secondary school curriculum included four years of informatics courses, and who have graduated from economics and gymnasium secondary schools, and other students. At this point, it should also be noted that the data regarding group A students are contained within the A1:K36 address area, while the data regarding group B students are included in the A37:K73 address area. With the help of the T-Test, a complex function for the test of the significance of difference of arithmetic means of samples was entered [4]. Table 3. displays the entered functions for the test of the significance of difference of arithmetic means of final grades, preliminary exams I and II, and the results regarding levels of significance.

TABLE II.
GROUPS OF STUDENTS CATEGORIZED ON THE BASIS OF SECONDARY SCHOOL DATA

	A	F	G	H	J	K	L	M
1	**RB**	**Smjer**	**Tip**	**Godine**	**Ocjena ukupno**	**Ocjena I kol**	**Ocjena II kol**	
2	1	Ekonomski	1	4	2	2	2	**Grupa A**
3	2	Opća gimnazija	1	4	4	3	4	
4	3	Opća gimnazija	1	4	5	5	5	
5	4	Opća gimnazija	1	4	2	2	2	
33	32	Ekonomski	1	3	2	5	1,5	
34	33	Ekonomski	1	3	2	1,5	2	
35	34	Ekonomski	1	3	5	5	5	
36	35	Ekonomski	1	3	4	4	2	
37	36	Turistički	2	3	1	1	1	**Grupa B**
38	37	Ekonomski tehničar	2	3	1	1,5	1	
39	38	Ekonomski tehničar	2	3	1	1	1	
40	39	Ekonomski tehničar	2	3	2	1	2	
41	40	Opća gimnazija	1	2	4	5	3	
42	41	Ekonomski	1	2	2	1	2	
43	42	Opća gimnazija	1	2	1	1,5	1	
70	69	Opća gimnazija	1	1	4	5	5	
71	70	Opća gimnazija	1	1	1	1,5	1	
72	71	Opća gimnazija	1	0	1	1,5	1	
73	72	Sportaši	1	0	3	3	3	

Table 3. illustrates that the level of significance for the first and second preliminary exam is $p < 0,05$, while the level of significance for the final grade is $p < 0,01$. Based on this data, it can be concluded that the hypothesis of the significance of difference between groups A and B was affirmed, i.e. that the students who had a better quality and more intensive computer science education in secondary school, as well as a better quality general secondary school education, and whose curriculums were compatible with college curriculums, were more successful on average than other students.

TABLE III.
T-TEST RESULTS

Grades	Recorded function	Level of significance
Preliminary I	=TTES T(J2:J36;J37:J73;2;2)	0,014239
Preliminary II	=TTES T(K2:K36;K37:K73;2;2)	0,02797
Final grade	=TTES T(I2:I36;I37:I73;2;2)	0,004488

The table demonstrates that the highest level of significance was achieved in the testing of arithmetical means of the final grades, which was calculated to be $p < 0,01$. This result is particularly interesting from the viewpoint of the Information Science teaching curriculum according to Bologna. In other words, according to the Bologna system, the final grade is no longer calculated as a simple arithmetical mean of the grades achieved in the first and second preliminary exam but, rather, the final grade includes other elements, such as a continuous presence in class, activity during class, points scored in class assignments, homework, etc. This way, it is possible to achieve complete insight regarding attributes such as quality of work, working habits, and the results achieved by students, the origins of which are a result of the process of secondary school education.

VI. CONCLUSION

In this paper, we have analyzed the influence of secondary school education on the success of computer studies education in college. Two groups of students were formed – one group containing students whose secondary school curriculum included four years of informatics courses, and students whose curriculum included three years of informatics courses, and who have also graduated from an economics or gymnasium secondary school. The hypothesis of the paper was confirmed, and it was proven that secondary school has a significant influence on the success on informatics education in college. The hypothesis was proven by testing the significance of the difference of arithmetical mean values of informatics course grades between the formed groups of students.

The significances of difference were tested for the first and second preliminary Computer Studies exam, as well as for the final grade. The significance of difference for the first and second preliminary exam is on a $p < 0,05$ level. The highest level of significance was achieved when testing the arithmetical means of the final grade, wthe result of which was $p < 0,01$. This result is particularly interesting from the point of view of the Computer Studies teaching program according to the Bologna system.

The research demonstrates that the influence of secondary school education is an important factor of success for higher computer studies education. In the course of the research, three measurable influence criteria were analyzed: the number of school years which included Computer Studies in the curriculum, the type of secondary school, and the secondary school's orientation. These criteria represented a broad evaluation of the

realization of a synergic influence of the factors of computer studies education in secondary school, and the factors of general education, which are mentioned in sections 2 and 3, and which, according to the results of the research, are realized up to a significant level.

The proven hypotheses in this research indicate the significance of the continuity of computer studies in higher education. In the Information Business course of the Faculty of Economics in Rijeka, the computer courses are allocated to each school year, with most computer courses in the fourth and fifth year of the postgraduate studies. The allocation of computer studies to each school year on the Faculty level should enable the synergy of the factors of general education and higher computer studies education on a higher level, towards achieving excellence in the education and training of human potential, with interdisciplinary knowledge of economics and computer studies.

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