Informatics teaching methodology in improving informatics students’ competencies

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Abstract Main task of the research is to examine the level of IT knowledge and skills in the student population of the Faculty of Transport and Traffic Engineering in order to improve IT competencies of students of this profile. The principal aim is to develop a methodology for the advancement and harmonisation of curricula and the improvement of teacher IT competencies in compliance with European standards and the needs of transport and traffic engineering faculties. Additionally, the aim is to implement such a methodology, i.e. to modernise the IT teaching process by using new teaching tools and on-line tests to assess students’ knowledge and skills in order to improve their informatics competencies.

Keywords— information technology, teaching, informatics competencies, test of knowledge,

I. INTRODUCTION

The concepts of competency and general competency are synonyms for the basic skills, knowledge, resourcefulness, and literacy as well as mastery of a certain area. The word “competency” signifies a combination of skills, knowledge, aptitudes and attitudes. Definition: “Key competences are a transferable, multifunctional package of knowledge, skills and attitudes necessary to every individual for their self-realisation and development, inclusion and employment. They should be developed by the end of compulsory education or training, and should represent a basis for further learning as part of lifelong learning”[3]. To develop informatics competencies at transport and traffic engineering faculties it is necessary to improve the informatics knowledge and skills in students. Also, IT education of students must be harmonised with European standards (FCDL - Finnish Computer Driving Licence, ECDL – European Computer Driving Licence) and the courses of professional informatics education in the field of traffic engineering. What competencies should students of transportation and traffic engineering faculties develop during a course of informatics? Should they improve their general informatics competency or should their education rather be based on the informatics competencies for specific purposes? One of the most important preconditions for students to gain specific informatics knowledge in the field of traffic engineering is to have previously gained the basic knowledge of informatics.

Students develop informatics literacy during their primary, secondary and self-education. The factors that have impact on students’ development of new informatics competencies are: quality equipment in computer laboratories, the use of adequate course books, software legalisation and competences of teachers engaged in secondary and primary education. In late nineties, European Commission started the initiative for informatics literacy level advancement in Europe. The document resulting from it was the “European framework of key competences”, which plays a major part in the improvement of informatics competencies in European countries. This document enforced the standardisation of informatics knowledge and skills (ECDL – European Computer Driving Licence) and the harmonisation of educational systems of European Union countries. Within its reform of primary and secondary education, the Ministry of Education of the Republic of Srpska allocated a high percentage of funds for equipping computer laboratories, teacher education and forming school information centres. The aim of the investment was to provide better conditions for the development of basic informatics competencies in students in primary and secondary education. This is an important factor for the improvement of informatics competencies of students at transportation and traffic engineering faculties.

II. SUBJECT OF THE RESEARCH

The subject of the research is assessing the informatics competencies of the students of Transport and Traffic Engineering Faculty in Doboj in order to determine suitable teaching modalities adapted to the needs of students of traffic engineering faculties.
Due to the long-term interval spent in learning “Informatics” during primary, secondary and self-education, the question that imposes itself is how useful it is to include informatics in the curricula of traffic engineering faculties. The assumption is that during their previous education students already acquired the informatics competencies necessary for proper participation in the teaching process at traffic engineering faculties; therefore, there is no need for an enhancement of students’ informatics competencies to a higher level of knowledge. The question that imposes itself in the process of planning informatics lessons at the Transport and Traffic Engineering Faculty is: Should a model of general informatics teaching be adopted or should traffic engineering faculties rather create their own models of teaching informatics for specific purposes? The following study results from an attempt to answer this question. [1]

The process of developing informatics competencies can prove to be of greater value from the perspective of the already functional methodologies than from the perspective of effects expressed through the ECTS system (ECTS – European Credit Transfer and Accumulation System), learning outcomes or the quantity and quality of the knowledge acquired. A fact to be also taken into consideration is that students gain part of their informatics knowledge through their own activity (the Internet, Social networks).

“Knowledge acquired based on a critical and creative transformation of the contents learned will be of greater value than knowledge gained through cognition, reproduction and information gathering” [2]

Some informatics contents are harder to acquire as they require reasoning and learning through discovery based on the engagement of various thinking skills and a creative and critical approach to studying informatics subjects. In that way, students acquire high quality knowledge which cannot be forgotten, which is easily structured into cognitive schemes, applied, transformed and used in various profession-specific subjects which require informatics knowledge.

We can conclude that informatics literacy and the improvement of students’ informatics competencies comprise a unique system. “A complex evaluation system must initiate and generate developmental changes in didactic-methodological and pedagogical organisation of university teaching as a whole” [7]

III. RESEARCH AND THE RESULTS

The research is based on measuring students’ basic informatics competencies acquired during primary and secondary education. In order to determine students’ informatics competency, as a diagnostic parameter, it is necessary to analyse students’ achievement in secondary education in terms of their final grades in informatics subjects. For data reliability, diagnostic testing of students’ knowledge and skills was organised based on informatics teaching modules and in compliance with the rules which follow the logic of knowledge assessment. Students were tested with two diagnostic tests of the same structure, with multiple-choice questions, which were used to assess their formerly gained informatics knowledge and skills. The test questions were formed by using the European standard data base (ECDL – European Computer Driving Licence).

The first diagnostic test (Test of Knowledge) aimed at assessing students’ informatics knowledge according to the European standard.

The second diagnostic test (Test of Skills) aimed at the evaluation of students’ informatics skills according to the European standard.

One of the main parameters for the assessment of informatics knowledge and skills is the system of measuring students’ aptitude. The concept of “measuring” herewith means a certain standard which is used to test the level of informatics knowledge and skills in the students of transport and traffic engineering faculties. A number of measuring instruments were used for the evaluation of variable informatics parameters in the students’ system of informatics competencies. One of them was a questionnaire related to students’ final mark gained in secondary education and the type of school they attended. Evaluation of the Informatics as a subject also represents an important instrument of determining informatics competencies in students during their education at transport and traffic engineering faculties. The internal evaluation of informatics as an academic subject at transport and traffic engineering subjects can help us determine three most important parameters in the system of informatics teaching, and they are:

- The evaluation of informatics skills helps the professor/teaching assistant to gather the data on the knowledge and skills which the student has gained. The evaluation of students’ overall informatics knowledge includes the assessment of that knowledge, too.
- Measuring is done to determine the quantitative features of students’ achievement and performance.
- Assessment represents evaluation of students’ informatics knowledge and skills according to previously determined criteria.

The process of self-evaluation at transport and traffic engineering faculties can also have multiple benefits. It can serve students for a self-improvement of informatics competencies and teachers for giving them proper guidance in that process.

Aims of the research

In the process of informatics teaching the important issue is defining the aims of teaching informatics at transport and traffic engineering faculties bearing in mind students’ previous knowledge and skills. Using computerised classrooms, the application of standardised teaching syllabuses based on modern teaching principles, and
competent teaching staff are the prerequisites for the fulfilment of the aims of teaching informatics. [8]
The main objective of this research is to determine students’ previous knowledge and skills in the field of informatics in order to take further steps for the improvement of informatics competencies in students of transport and traffic engineering students. The syllabuses of the subjects in the area of traffic and transportation also imply students’ informatics competency. Therefore, the teaching and assessment processes in other profession-related subjects include the assessment of students’ informatics knowledge and skills. In that sense, one of the aims of this research is to work out a suitable modality of evaluation of students’ general informatics knowledge and skills in order to improve the specific informatics competencies of the students of transport and traffic engineering faculties. The major aim of the research is the analysis of forms and ways of informatics teaching at transport and traffic engineering faculties in order to improve students’ competencies to a level matching European standards. [7]

Research hypotheses
New informatics teaching methodologies applicable solely at transport and traffic engineering faculties with the aim of improving students’ competencies will be implemented only if the following hypoteses are confirmed:

- \((H_0)\) Previously developed informatics competencies in the first year students of the transport and traffic engineering faculty acquired through primary, secondary and self-education do not meet the requirements for student informatics competencies prescribed by European standards.
- \((H_1)\) Previously developed informatics competencies in the first year students of the transport and traffic engineering faculty acquired through primary, secondary and self-education do not meet the requirements for student competencies prescribed by European standards.

Population and the sample
The research population consists of 219 first-year students of the “Transport and Traffic Engineering Faculty” of Doboj University in East Sarajevo enrolled in the academic year 2013/14 who are attending an informatics course for the first time. [5] The used sample belongs to the category of intentional sampling and makes a group of 170 tested first-year students of the Transport and Traffic Engineering Faculty in Doboj. In percentages, the used sample makes 77.63% of the total population, so that the sample can be considered valid for further research.

Variables and the mode of data acquisition
The variables in this analysis are presented with the data gathered in two diagnostic tests (Test of Knowledge and Test of Skills) held during a lesson of “Informatics” and the third variable marks the high-school students’ attainment in informatics expressed as the Average grade in high school.

The aim of the diagnostic tests is to show the overall knowledge and skills (informatics competencies), which students gained during their previous education. During the study we gathered the following data: demographic data about students’ gender, the structure of the secondary school they finished, data about students’ attainment expressed as the average high school grade, data on the results of the diagnostic tests of knowledge and skills. All the data collected during the study are shown in the following diagrams. According to the demographic data about students’ gender, out of 170 respondents, 109 were male and 61 female students. Diagram 1. shows an obvious dominance of male population because the study was conducted at the transport and traffic engineering faculty which typically has more male students. Therefore, such gender ratio was expected.

Diagram 1. Demographic student structure (male, female)

By using a questionnaire with the students of Transport and Traffic Engineering faculty in Doboj, we collected the data on the structue of secondary schools they finished,

Diagram 2. Types of secondary schools finished by the tested students expressed in percentage (Transport and Traffic Engineering School, Vocational Schools, Grammar School,

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5 Students who are repeating the academic year are not included in the population.
Economic School). The indicator of students’ attainment in informatics during their high school education was their average final grade in informatics subjects.

The data gathered by testing students (Test of Knowledge and Test of Skills) are shown in percentages in the following diagrams (diagram 4. and diagram 5.). The total number of tested students is 170, whereby the first diagnostic test (Test of Knowledge) was done by 128 students, and the second diagnostic test (Test of Skills) was done by 127 students of the Transport and Traffic Engineering Faculty in Doboj. The difference in the total number of the tested students and those tested with partial diagnostic tests results from a different number of students who took part in each of the diagnostic tests.

The data gathered in the study will be processed by means of software tools and analysed according to statistical methods

Methodology

The statistical processing and analysis of the data was based on the use of the following tools: Microsoft Excel 2007 and IBM SPSS Statistics 20.

Data processing and analysis were based on the following statistical methods:

1. Presentation of the variable frequency distribution (Test of Knowledge, Test of Skills and Average grade in high school).
3. Kolmogorov-Smirnov (KS) test for proving the normality of variable result distribution (Test of Knowledge, Test of Skills and Average grade in high school).
4. Method of correlational analysis based on the Pearson coefficient of correlation between pairs of variables (Test of Knowledge – Average grade in high school and Test of Skills – Average grade in high school).
5. By means of a student or t test we determined the significance of correlation coefficient.
6. The analyses were done at the level of 95% reliability (probability of error $r \leq 0.05$).

Research results

The results of the diagnostic tests and average high school grades are shown in the tables of frequency and histograms.
Based on results shown in the tables of frequency and histograms we can suppose that the distribution for each variable is normal. The data shown above were included in a descriptive analysis and the results are shown in Table 5.

### Table 5. Descriptive statistics

<table>
<thead>
<tr>
<th>Test of Knowledge</th>
<th>Test of Skills</th>
<th>Average grade in high school</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>128</td>
<td>127</td>
</tr>
<tr>
<td>Normal Mean</td>
<td>24,898</td>
<td>20,457</td>
</tr>
<tr>
<td>Parameters</td>
<td>Std. Deviation</td>
<td>3,573</td>
</tr>
<tr>
<td>Most Absolute</td>
<td>0,074</td>
<td>0,121</td>
</tr>
<tr>
<td>Extreme Positive</td>
<td>0,074</td>
<td>0,064</td>
</tr>
<tr>
<td>Differences Negative</td>
<td>-0,074</td>
<td>-0,121</td>
</tr>
<tr>
<td>Kolmogorov-Smirnov Z</td>
<td>0,840</td>
<td>1,360</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>0,481</td>
<td>0,050</td>
</tr>
</tbody>
</table>

a. Test distribution is Normal.
b. Calculated from data.

The normality of distribution was checked by means of Kolmogorov-Smirnov (KS) test.

### Table 6. Results of KS test

<table>
<thead>
<tr>
<th>Test of Knowledge</th>
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<th>Kolmogorov-Smirnov Z</th>
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</tr>
<tr>
<td>Extreme Positive</td>
<td>0,074</td>
<td>0,000</td>
</tr>
<tr>
<td>Differences Negative</td>
<td>-0,074</td>
<td></td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>0,481</td>
<td></td>
</tr>
</tbody>
</table>

a. Test distribution is Normal.
b. Calculated from data.
Based on the results shown in Table 6, where the KS test results for the variables are higher than the highest deviation of the empirical distribution from the normal curve, we can conclude with certainty that distribution for all the three variables is normal. By method of correlation we test the connection between the variables (Test of Knowledge, Test of Skills and Average grade in high school). Based on the proved normality of distribution of the research results we used the Pearson correlation coefficient. Based on the test of correlation and the test of significance of the r correlation coefficient, we can say that the dependence between the diagnostic tests and individual grades in high schools is negligible.

Diagnostic tests of knowledge and skills and the average grade high schools in informatics subjects can be used as a valid proof of informatics competencies of students before they are enrolled on a course of Informatics at the Faculty of Transport and Traffic Engineering in Doboj.

Based on the diagnostic test results (Diagrams 6 and 7) and final high school grades, we reached the following conclusion: We can confirm the H0 hypothesis that the informatics competencies of the first-year students of the Transport and Traffic Engineering Faculty in Doboj do not comply with the competencies defined in European standards, which was proved in a range of statistical analyses. An insight into the statistical analyses done shows that there are no statistically significant correlations between the average grades in high school and the diagnostic tests.

III CONCLUSION

Based on our former experience and the results of the analysis of the level of informatics competencies of the first-year students at the Transport and Traffic Engineering Faculty in Doboj, we can consider the following needs and possibilities. A redesign of the current curricula which includes the standardisation of informatics syllabuses (ECDL – European Computer Driving Licence). Introducing new informatics contents and skills with the aim to improve the informatics competencies of students and their implementation with the aim of the teaching process optimisation. Modelling a system of informatics education at transport and traffic engineering faculties by which we encourage students for individual work on their own informatics knowledge and skills. Implementation of a system of evaluation by which we control further steps in the organisation of teachinginformatics and adapt it to the specific needs of the transport and traffic engineering faculty.

REFERENCES
