TRANSPORTATION ENGINEERING COURSES AT UNIVERSITY STUDIES OF FACULTY OF CIVIL ENGINEERING, UNIVERSITY OF RIJEKA

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Abstract

Study reform based on the Bologna declaration principles was an opportunity to make proper check up of the practice at the traditional civil engineering studies that have been delivered at the Faculty of Civil Engineering University of Rijeka.
The goal of this paper is to present structure, implementation and success at the courses it the field of transportation engineering at the reformed studies at the Faculty of Civil Engineering in Rijeka. To assure improvement of the studies, learning outcomes were defined during academic year 2008./09. for all studies and courses delivered at the Faculty. Those defined for the transportation engineering will be presented as well as activities that are undertaken in order to improve final competencies and motivate students for field and civil engineering study in general.

Keywords: transportation engineering, learning outcomes, assessment

1 Introduction

The traditional (pre-Bologna) studies of civil engineering have been successfully conducted for more than several decades, along with periodical lesser changes. Having been initiated by the implementation of Bologna declaration principles in the Croatian university education system, the study reform provided the opportunity to conduct a thorough analysis of the past experiences and contents which have been offered by the studies. The surveys, carried out among the employers and the graduated students by the Faculty of Civil Engineering in Rijeka (in 2006 and 2009), have shown that both parties are generally satisfied with the competences acquired by studying at this Faculty. [1], [2] In both surveys the theoretical knowledge of the graduated students was assessed as very good. However, the competences such as "the ability to resolve practical engineering problems" were assessed as not so good, which points out to the insufficient amount of practical work or some other form of immediate experience in resolving real engineering problems. The recently conducted survey of 2009 has shown that the graduated students have insufficiently developed generic competences which enable easier adaptation to work requirements in different environments or unfamiliar circumstances. The development of those competences requires introduction of changes into traditional teaching methods by including the students into curricular and extra curricular activities more actively. The aim of this paper is to present the learning outcomes as well as the course structures, student obligations, ways of learning outcome assessments and student success at courses from the transport engineering field which have been taught at the Faculty since the reformed learning outcomes have been established. The paper also presents possible ways of motivating the students through their obligations and including the students into extra curricular activities which enable them to develop both professional and general competences.

2 Learning outcomes of transportation engineering field at University Studies of Faculty of Civil Engineering in Rijeka

The adopted structure of university studies of civil engineering is the same at all faculties of civil engineering in Croatia and has been verified through curricula as such at the Faculty of Civil Engineering in Rijeka. The undergraduate university study (3 years, 180 ECTS) has been introduced since 2005/06, while the graduate university study (2 years, 120 ECTS) has been introduced since 2008/09. Undergraduate university study comprises 32 mandatory and 19 elective subjects. From the transport engineering field, one of them is mandatory (the course: Road Design) and two are elective (Transportation Planning and Design and Railroads). Graduate university study at the Faculty of Civil Engineering in Rijeka is organized through modules of specific field. Therefore, from the transportation engineering field the students are offered the following modules: Road Planning and Design and Pavement Structures. Each module has 3 mandatory and several elective subjects and offers the student at least 30 ECTS. During the year 2008/09 both learning outcomes at the undergraduate and graduate university study and their courses, as well as education of the teachers were worked at within the project which was financed by the National Foundation for Science. [2] The education of the teachers comprised both the defining of learning outcomes and the implementation of learning outcome concept. The propositions for defining the learning outcomes at a certain level were adopted form the Croatian Qualification Framework. [3] The CQF, which is based on the European Qualification Framework and the Dublin descriptors, defines levels for each education stage in sense of: knowledge (theoretical and practical), competences (cognitive, psycho-motor and social) and the category of responsibility and independence.

The learning outcomes for mandatory part of the undergraduate study programme for the field of transportation engineering is listed in continuation.

Learning outcomes at the level of *undergraduate study – mandatory part* of the field of transportation engineering:

- Differentiate road construction conditions regarding technical conditions
- Define the basic characteristics of town roads of different categories.
- Make a design of an open road section under simple conditions at the preliminary design level (construction elements and ground earthwork).
- Make a calculation of a flexible pavement structure by using the empirical method.

Learning outcomes at the level of *graduate study – mandatory part* of the field of transportation engineering:

- Define and explain route design principles in complex conditions.
- Analyze the spatial, urban and other conditions which are important for route design.
- Design an entire section of the road taking into consideration the spatial conditions of the route (at the final design level).

Module I:

- Make a design of construction elements used in complex road design in the city (intersections at level and out of level, roundabouts).
- Make various variants of an intersection design under complex city traffic conditions.
- Make a design of horizontal and vertical traffic signs at a complex intersection.
- Analyze conditions of different types of traffic in the city and propose the variant conditions.
- Define and explain the application of different road intersection types Define the town road categories, explain their function and construction principles.
- Define and explain the ground concepts of regional and transportation planning
- Analytical survey of problems related to the different aspects of city traffic.

Module II:

- Analyze the conditions of road construction regarding the surroundings, that is, the geological, geotechnical, hydrological and other conditions of road design and construction.
- Make a calculation of a pavement structure and test the stress.

- Define and explain the principles of structural road construction (empirical and theoretical approach), traffic load influence and influence of the surroundings.
- Define road construction material characteristics.
- Define the methods and a possible application of pavement maintenance procedure.
- Define and explain the application and execution of earthwork (cuts, embankments, slope protection, etc.) in relation to the structure construction conditions.

Defining of learning outcomes enables the future students to clearly understand what they will be able to do after having completed the study. At the same time it also enables the employers to understand which competences are acquired by the students within the Bologna study scheme. Recognition of bachelors' competences by the employers is of a great importance because it enables the bachelors to find employment should they decide not to continue the studies.

3 Transportation engineering field at the undergraduate study level

The mandatory course of the second undergraduate study year[4] (summer semester) is the course Road Design which has 4.5 ECTS, 30 lecture classes and 30 classes of tutorials. Besides the mentioned mandatory course there are two courses from the Transportation Engineering field that are offered as elective courses in the last semester (the sixth semester):

- Railroads – 5 ECTS (45 classes of lectures and 15 classes of practice)
- Traffic Planning and Design - 5 ECTS (30 classes of lectures and 30 classes of practice).

3.1 Learning outcomes at the Road Design course

During the curriculum reform the only mandatory course, Roads, which had the same status at former undergraduate study, underwent changes in contents. While doing so a special attention was paid to which tasks from the road design field the students should be able to perform after having completed the undergraduate study. This is of great importance because those students who do not take elective courses from this field and then later continue their studies at any of other Modules graduate as masters of civil engineering but have poor competences in relation to road design. By defining the learning outcomes and assessment methods the most significant knowledge and competences which the student acquires through the course are also defined. As a result the student knows in advance what is expected of him during the course and, at the same time, the teachers have a clearly defined objective of the course as well as the basic elements for defining the criteria by which the favourable grade is obtained. Since 2007/08 a continuous student evaluation and assessment though several activities during the semester has been implemented at the University of Rijeka. [5] The student can gain a total of 70 points during the semester while the maximum of 30 points can be gained at the final exam. The past two generations of students could choose whether the course could be completed by actively participating in it during the semester or if the main part of the points would be gained at the final exam. According to the first model, for a favourable mark, the student had to gain at least 40 points during the semester and at least 15 points at the final exam. According to the second model the student had to complete a curriculum task during the semester (22 points), while the remaining 78 points could be gained at the final exam, out of which the minimum for a favourable mark is 39 points.

Table 1 presents learning outcomes, assessment methods, share of learning outcomes in the course and minimal number of points by which the student can gain points for a specific activity. After course analysis (contents, importance for curriculum in whole, etc.) it has been concluded that upon completion of the course the students should be able to calculate the geometrical road elements (horizontal and vertical) on their own. This part of learning outcomes is implemented through lectures and through project work. Other learning outcomes are at the level of understanding, defining or identifying because it is unrealistic to expect a high level of final outcomes due to the number of ECTS.

Table 1 Learning outcomes and assessment methods at the Road Design course

Learning outcomes	Assessment method	Number of points	
		max	min
Describe and sketch basic road elements, Describe history of road design and construction, list main historic roads in wider region	Written mid-exams	8	5 (62,5%)
· Calculate horizontal roads' elements of roads · Calculate vertical road elements	Written mid-exams	20	10 (50%)
· Differentiate road construction methods according to the site substratum · Explain the main impacts on road pavement structure construction · Describe and sketch basic elements of different city road categories	Written mid-exams	20	10 (50%)
Make a preliminary design of an open road section outside urban area	Completed and orally presented curriculum task	22	15 (68%)
Oral presentation with use of technical expressions or usage of different sources	Participation in different activities during lectures	Extra points 5	Non-mandatory autonomous activity
Basic learning outcomes assessment	Final exam	30	15

The described model ensures that the student gains the minimum level of knowledge, understanding and cognitive competences from all the planned learning outcomes, which was earlier not ensured in the same way, according to the model by which the students, after having attended the course (and made the curriculum task), take the exam according to the dynamics which they choose themselves. A possible shortcoming of assessing the work of students in this way is a partial knowledge acquirement which can make it difficult for a student to integrate the course content into a logical unit required for the engineering way of thinking. A mandatory final exam and final exam questions which comprise testing of the most important learning outcomes and establishing of their relations are the way by which this potential problem can be resolved.

3.2 Student success at the Road Design course

The model of student assessment and grading which was described under 3.1 has been applied at the Faculty of Civil Engineering in Rijeka for the last two academic years.

Table 2 Student success at the Road Design course

Academic year	Enrolled students	Completed course (model 70+30)	Completed course (model 22+78)	Passed exam
2007./08.	126 / 100 %	87 / 69 %	13 / 10 %	98 / 78 %
2008./09.	114 / 100 %	47 / 41 %	54 / 47 %	85 / 75 %

Table 2 shows the results which the students have accomplished after completing all the planned activities. It can be concluded that the students meet the course requirements successfully because the rate of the passed course exams has been 75%, respectively 78% in the past two years.
The analysis of successfulness in different activities and the analysis of successfulness in resolving specific tasks at the final exam point out the necessity of continuous examination

of set tasks and adopted criteria. This year's plan includes increase in number of lectures and practice classes which are related to the very road design, that is, the calculation of geometrical elements because some knowledge insufficiency of that matter has been detected.

4 Transportation engineering field at the graduate study level

During the year 2008/09 the first generation of students enrolled the graduate study at the Faculty of Civil Engineering in Rijeka, the Construction module and the inter-disciplinary module Urban Engineering. Five of the students who enrolled the modules of Urban Engineering took classes from the transportation engineering field. For the first time, the new generation of students activated the new courses: Road Design, Road Intersection Design, City Traffic and Transportation Facilities, a somewhat changed course from the undergraduate study. Since the group was small, the student activity and successfulness at courses was very high. The next generations with a larger number of students will point out the necessity to make curriculum adjustments. The ways and methods which were conducted through the classes and through extra-curricular activities of students comprising the expert design creations are described in the following sub-chapters.

4.1 Encouraging student activity

According to the CQF, in relation to the cognitive skills (or, more simply said, the problem resolving skills) the graduate study level should teach the students "the abstract and creative way of thinking required in research for developing new knowledge and procedures and for integration of different fields". In order to develop the mentioned cognitive abilities different teaching methods have been applied so that the students would be encouraged to analyze and express their own opinions under unfamiliar circumstances, provide a reasoned analysis of the offered solutions, an analysis of variant solutions and other.
The teaching methods of, e.g., City Traffic course included the following:

- *Field work:* an individual field trip through specific town streets, recording of the state and identifying problems in pedestrian traffic and then proposing a solution. The task was performed in pairs, the members were chosen randomly in order to prepare the students for the situations in which they will have to work with unknown (or less known) co-workers. The teacher prepared the task instructions in advance. Two groups of students worked in the same town district. After the presentation of the solution and the discussion the other students were invited to choose the better of the two offered solutions.
- *Analysis of the offered solutions:* Analysis of the graduation theses which dealt with city traffic through variant solutions. The students were given an insight into a thesis and were asked to analyze, assess and decide about its applicability, necessity for additional research or additional elaboration.
- *Resolving of practical tasks in class:* Teams of students resolved specific tasks in classes (e.g., a solution of an intersection under specific conditions made in rough draft, or other). After having completed the tasks the teams "checked" each other's solutions and commented on them.

4.2 Including the students into professional project delivery

During the academic year 2008/09 two activities were performed in which the students took part:

- *Cadastral office of culverts and walls* – for the County Road Management of Primorsko-goranska County [Figure 1.] The data processing was performed mainly by the students who used GIS application

· *Analysis of the existing roundabouts and potential locations for new roundabouts in the city of Rijeka – for City of Rijeka* [Figure 2.] The activities comprised the analysis of the current situation (traffic count, regional planning documentation), project design of a roundabout (at the preliminary design level) and assessment of suitability of the proposed solution.

Figure 1 Students in the field work

Figure 2 Roundabout (student work)

It can be stated that the field work was of great value for the students because it enabled them to develop specific competences such as: operating the field equipment, adaptation to field circumstances, orientation in space and with bases which will be very useful to them for their further professional career. According to the dynamics of contracted deals, those students, primarily from the graduate study, who show interest will be included in such activities also in future.

5 Conclusion

The study reform according to the principles of Bologna declaration was used at the Department for Transportation Engineering at the Faculty of Civil Engineering, University of Rijeka for reforming the course curricula from the field. The reform is based on introducing the learning outcomes concept, that is, on combining the learning outcomes, teaching methods and assessment methods of student work by continuously assessing specific tasks and activities. The first results show that the students accept the novelties well: the success at the courses is satisfactory, the students are willing to participate in the offered extra-curricular activities, the work of students on specific tasks shows that they are able to adapt themselves to different circumstances and requirements. Specific indicators (such as rate of passing the exams, successful completion of activities and tasks, student evaluation, employer evaluation and other) should be closely watched in the future and the curricula should be changed and improved based on those data permanently.

References

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