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USE OF PROBLEM BASED LEARNING IN HIGHER EDUCATION: STUDENT WORKSHOPS AT THE FACULTY OF CIVIL ENGINEERING IN OSIJEK

Sanja Lončar-Vicković, Zlata Dolaček-Alduk, Dina Stober

Subject review

The interdisciplinary students' workshop "Where the Railway Is?" tried to devise sustainable, environment friendly and cost effective solutions for the reconstruction of an abandoned railway line in Baranya, Eastern Croatia. The workshop integrated different architectural and organizational aspects of the construction process and was a result of cooperation between twenty students of the final, fourth year of civil engineering studies at the Faculty of Civil Engineering in Osijek, and a group of teachers of subjects Industrial Buildings, Construction Management and Masonry Structures at the Faculty. Workshop was devised with two main goals in sight; one was to acknowledge significant changes in higher education in Croatia in the last few years and incorporate them, together with other contemporary accomplishments in teaching at university level, into civil engineering studies. The other goal for the Faculty was to stress its social role and take an active and responsible approach to society's problems.

Keywords: *field work, learning outcomes, problem based learning, students' workshop*

Primjena učenja na problemima u visokom obrazovanju: studentske radionice na Građevinskom fakultetu u Osijeku

Pregledni članak

Interdisciplinarna studentska radionica "Gdje je pruga?" pokušaj je oblikovanja održivog, ekološkog i troškovno prihvatljivog rješenja sanacije napuštenog željezničkog pravca u Baranji, istočna Slavonija. U radionici su integrirani različiti arhitektonski i organizacijski aspekti procesa gradnje kao rezultati suradnje dvadeset studenata četvrte, završne, godine studija građevinarstva na Građevinskom fakultetu u Osijeku i grupe nastavnika obveznih predmeta studija: Arhitektonske građevine, Organizacija građenja i Zidane konstrukcije. Radionica je osmišljena s ciljem implementacije promjena u visokom obrazovanju posljednjih godina zajedno s drugim suvremenim postignućima u nastavi na sveučilišnoj razini u obrazovanje građevinskih inženjera. Osim toga, radionica je imala za cilj promovirati ideju veze između kulturnog i arhitektonskog naslijeđa te uključiti studentsku populaciju u regionalne razvojne silnice.

Ključne riječi: *ishodi učenja, problemsko učenje, studentska radionica, terenski rad*

1 Introduction

Uvod

Interdisciplinary students' workshops at the Faculty of Civil Engineering of the Josip Juraj Strossmayer University of Osijek have first started in the 2000/2001 academic season. Those workshops were created for students attending the final year of civil engineering studies and they integrated different architectural and organizational aspects of the construction process. Two main directions were crucial in developing such specific workshops; first being educational and second social.

Educational reasons were transparent; teachers of such specific core subjects like Industrial Buildings, Construction Management and Masonry Structures felt that students, close to completion of their studies, have rarely had an opportunity to treat a building as a whole, rather, they only dealt with specific aspects of civil engineering within a certain study subject (Figure 1). Within the subject Industrial Buildings students designed industrial objects, within Construction Management they calculated the process and costs of the construction and within Masonry Structures students designed and calculated bearing building structures.

Social reasons were equally important to the Faculty; there was a strong conviction that students needed to be more visible and active in their social environment. The need for them to spot and to deal with real problems was also perceived as significant.

We therefore created a type of workshop, conducted every academic year since 2000, that provided students with problems existing in their surroundings, guided them to potential solutions with help of various teaching methods and encouraged a multifaceted approach to building and construction themes through interdisciplinarity and team work.

2 Educational Foundations for Students' Workshops

Obrazovni aspekti studentske radionice

2.1

Learning Outcomes

Ishodi učenja

In the last couple of decades the paradigm of learning/teaching has been changing from a teacher centred to a student centred approach to learning, from an input based



Figure 1 *The interdisciplinarity of educational problem*
Slika 1 *Interdisciplinarnost obrazovnog zadatka*

approach to an output based approach. As an input based process education was expressed in workload and length of studies (hours, semesters, years) while as an output based process it is expressed in the knowledge and skills to be achieved. At the end of an educational process the student is expected to achieve certain competencies that are defined as combinations of attributes in terms of knowledge and its application, skills, responsibilities and attitudes a person has to perform in a professional context [1]. Simultaneously, the accent shifted from teaching objectives (specific statements of teaching intention which indicate the subjects that a teacher intends to cover in a block of learning) to learning outcomes that are statements of what a learner is expected to know, understand and/or be able to do at the end of a period of learning [1].

Learning outcomes are defined as generic learning outcomes (Dublin descriptors), orientation learning outcomes (professional or academic) and subject/discipline specific learning outcomes. Specific learning outcomes for technical disciplines were outlined by Accreditation Board for Engineering and Technology (ABET) and in the course of students' workshops we tried to emphasize several of those detailed learning outcomes like "an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability" or abilities to function on multi-disciplinary teams, understand professional and ethical responsibility, an ability to communicate effectively and have a knowledge of contemporary issues.

2.2 Project and Problem Based Learning Projektno i problemsko učenje

The creators of students' workshop at the Faculty of Civil Engineering in Osijek, carefully researched contemporary teaching methods and chose teaching methods called Project based learning and Problem Based Learning as the most suitable for dealing with some of the problems that surfaced in civil engineering studies. Project based learning (PBL) is an approach for classroom activity that emphasizes learning activities that are long-term, interdisciplinary and student-centered or use of classroom projects, intended to bring about deep learning, where students use technology and inquiry to engage with issues and questions that are relevant to their lives [2]. PBL is a teaching method that engages students in learning knowledge and skills structured around complex, authentic questions and carefully designed products and tasks.

In PBL students collaborate, organize their work and manage their time as well as present their work product. It is also important that presented issues relate to students' lives and that their work is outcome based with a product – design, presentation or real action – as a result of the project.

This approach is less structured than traditional classroom activities that are conducted by a teacher; in PBL the teacher is a moderator, a facilitator of learning activities and provider of feedback after the project. Students research, work and design solutions collaboratively¹⁾.

¹⁾ Some authors warn that a potential negative aspect of PBL is unfocused learning and waste of classroom time.

Problem-based learning is a similar pedagogic approach; however, problem-based approaches structure students' activities more by asking them to solve specific (open-ended) problems rather than relying on students to come up with their own problems in the course of completing a project [2].

2.3 Engineering Education: knowledge and skills Obrazovanje inženjera: znanja i vještine

Since the establishment of the Faculty of Civil Engineering in Osijek in 1976²⁾ the width and diversity of civil engineering studies have significantly grown as well as the variety of jobs a civil engineer can obtain. As a result of various factors like the complexity of civil engineering studies, construction "boom" and scarcity of graduate civil engineers, most of civil engineering graduates in Croatia³⁾ now hold managerial jobs.

According to a study from 1994 [3], a fundamental difference in desired knowledge and skills was observed depending on the place on the job ladder; lower positions requiring a high percentage of technical knowledge while higher positions requiring a higher (as much as 90%) percentage of economic and managerial and other related general or "soft" skills.

Two important surveys were conducted researching knowledge and skills important for civil engineering managers in Croatia; first was conducted in 1989 [4] and the second in 2002 [3]. Authors of the 1989 survey concluded, based on graduates of the Faculty of Civil Engineering in Zagreb in the period between 1955 and 1985, that for a civil engineering manager technical knowledge was paramount and that the "ability to control expenses" was of least importance. The results of the 2002 research showed how huge a political and economical change occurred in the period between the two studies; now the civil engineering graduates ranked knowledge in project management and management science as most important. The 2002 study also researched characteristics of project managers in general and the analysis stressed capability of making decisions, coordinating tasks and people and possessing organisational skills as most important.

The observed importance of "soft" skills was a powerful incentive in the creation and structuring of students' workshops at the Faculty of Civil Engineering in Osijek.

2.4 Social Aspects of Students' Workshops Društveni aspekti studentske radionice

Interdisciplinary student workshops at the Faculty of Civil Engineering of Osijek started in 2000. Since the very beginning workshops were oriented to the region Baranya, a rural area surrounding the city of Osijek, and a border zone to Hungary and Serbia. Troubled historical periods have deeply marked this area and its position influenced specific spatial and social phenomena. The students' workshops originated with a focus on Baranya's rich building history as

²⁾ In 1976 called Higher Civil Engineering School.

³⁾ This reference was based on a survey of job structure of engineers that graduated at the Faculty of Civil Engineering in Osijek in the period between 1998 and 2008.

a starting point for a positive view of this area. The theme of this years' workshop was "a trace in space" – a trace of the former railway, now defunct, which connected the Baranya triangle from the west to the north-east.

At the beginning of the 20 century, the Baranya area was marked by the economic bloom. The infrastructure was rapidly developing, and the historic north-south connection was enriched by railway trails in the east-west direction. There were three railway routes in the Baranya triangle in that period – the state line, direction north-south; the industrial line, west-northeast; and the agricultural line, west-east (Figure 2). Such a picture of the railway traffic held till the end of the 60s', when the road traffic took over, and the railway became unprofitable. The state policy in that very moment did not see railway traffic as important and has therefore put a stop to it. Deconstruction of the railway track was carried out in 1968. What is still left in the area are the seven railway stations in Baranya, which are silent witnesses of a disappeared infrastructure. Today's length of the railway amounts to just 44 % of the old ones and the Baranya area is marked by the polarization of the population and the economy around the main road and railway corridor, direction north-south. The rest is viewed as a sub-area faced with depopulation and stagnation. Profiling of this rural area in terms of rural tourism, rich gastronomic offer and sports tourism has defined this year's workshop tasks and the main goal was set – recycling of the railway track.

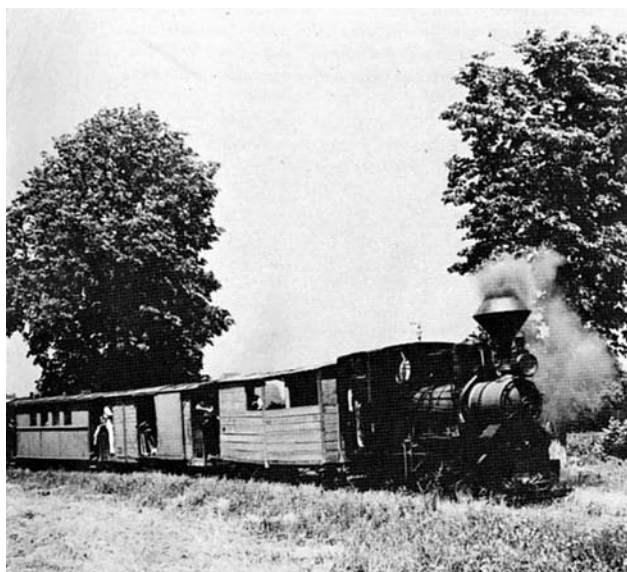


Figure 2 Belje railway 1950 (source: *Tri stoljeća Belja*, page 101)
Slika 2 Beljska željeznica 1950. (izvor: *Tri stoljeća Belja*, strana 101)

The main characteristic of the project lies in the fact that its participants are the students of civil engineering who rarely meet with spatial problems, so they intuitively and rationally respond to them and in such a way confirm the interdisciplinarity of urban planning. The basic plan of the workshops repeats itself every academic year and during the semester it develops in two basic parts – field work and classroom activities. Every year the topic has been carefully chosen, with the respect to the data researched by teachers in charge of the workshop.

3

Case study:

Student Workshop "Where the Railway is?"

Primjer: Studentska radionica "Gdje je pruga?"

During the winter semester of the academic year 2007/2008 at the Faculty of Civil Engineering of the Josip Juraj Strossmayer University of Osijek, a project of the students' workshop under the name "Where the railway is?" started. The project was organized and carried out by teachers PhD Sc. Sanja Lončar-Vicković, PhD Sc. Zlata Dolaček-Alduk, B.Sc. Dina Stober and MSc. Đurđica Matošević. It was planned as an interdisciplinary workshop consisting of mutual semester tasks elaborated from the obligatory study subjects: Industrial Buildings, Construction Management and Masonry Structures. The following students of the fourth-year study took part in the workshop: Domagoj Batinić, Mihael Bebek, Nives Beljan, Željka Beronja, Ivan Blažević, Nikolina Brkić, Josip Đimber, Mario Galić, Marina Glavota, Tomislav Hlišić, Vedran Jemrić, Andrej Kačarević, Josip Klaić, Ivan Kraus, Dragan Marković, Anita Oršolić, Ana Panić, Barbara Rakitić, Tamara Šimić-Jelić and Anto Zovkić.

3.1

Field Work

Terenski rad

First part of the workshop was field work. Twenty students took part in the workshop and they were divided in seven groups, each group being given one railway station (Figure 3). By field visiting the objects, the students defined the type units (seven existing railway stations), which, by the rule, were positioned in the suburb area of the villages. All buildings are privately owned, except for the one in Batina, which by the characteristics served as an exception confirming the rule.



Figure 3 Baranya county, polarization and recycling line
Slika 3 Područje Baranje, polarizacija i reciklirani potez

During the three days of field work conducted in November 2007 students had specific tasks. The subject Industrial Buildings set the following tasks: measuring all exterior and exterior elements of the stations and constructing a digital archive (Figure 4).



Figure 4 Measuring exterior in Baranjsko Petrovo Selo
Slika 4 Arhitektonsko snimanje objekata u mjestu Baranjsko Petrovo Selo



Figure 5 Digging the ground
Slika 5 Otkopavanje temelja

Limited by current residential purpose of the objects, students were able to measure two objects in full. The house in village Širine was empty and in good shape, so the owner kindly let us observe the interior, as well as the object in Suza village which was devastated, abandoned, without windows and front doors and in that way reachable. On the basis of these two objects and all seven photo-evidences of outside measures we confirmed the typological project for railway stations. The subject Construction Management defined these tasks: defining the status of materials and non bearing structures used in the buildings. The subject Masonry Structures used field work to check the status of bearing masonry structures like foundations and walls (Figure 5).

The description was based on the data of all seven stations which are not in original shape. The plan consisted of the well and the brick sanitary object in the yard, for the waiting passengers. The biggest changes were made in interior, during the rebuilding process into residential areas, so, for example, the waiting room became the living room.

As a result of field survey the conclusions were reached that all railway stations are single-story houses with a basement and an attic, built with bricks, walls' thickness 50 cm (Figure 6). Stations on the flood area, up the Danube

(Kneževi Vinogradi, Zmajevac, Suza) do not have a basement. Roof is a wooden construction, triple hanger with firmly preserved material. The front is plastered with lime mortar and wall corners decorated. The double windows are white-painted.



Figure 6 Railway station in Širine, typological project
Slika 6 Željeznička postaja u Širinama, tipološki projekt

Table 1 SWOT spatial analysis for the railroad route
Tablica 1 SWOT analiza trase željezničke pruge

| Strengths | Weaknesses |
|--|---|
| <ul style="list-style-type: none"> - closeness of the border at the outermost points of the trace (Hungary, Serbia) - firm object construction - recognizable of building typology - existing railway track base | <ul style="list-style-type: none"> - no perception of the whole - difficult approach to some objects - position of suburban objects - lack of infrastructure |
| Opportunities | Threats |
| <ul style="list-style-type: none"> - revitalizing of the whole and single points in space - combining with other objects on route - raising the quality of offer in the local area - east-west connecting as opposite to the polarization direction of Baranya | <ul style="list-style-type: none"> - spreading of the neighbouring warehouses - further objects' devastation - inability to fit into the area - competition - flood - mine danger areas |

3.2

Classroom Activities

Rad u učionici

The gathered data served as the basis for further work in classroom that went on for the whole winter semester of 2007/2008. The first assignment, conducted within all three subjects, was to lay out a design proposal for the whole (vanished) railroad route as well as for specific objects. By developing the SWOT analysis for the whole route students set out a full vision and consequently defined contents for the route from the west to the east and back (Table 1).

The concept set the revitalization of the traffic route for vehicles like bicycles, horse carriages, pedestrians, nordic skiers etc. The objects at the traffic corridor were supposed, with their contents, to fulfil the needs and wishes of their users, as well as to contribute to development of Baranya as a tourist region with its gastronomic offer from the local resources.



Figure 7 Classroom work on SWOT analysis
Slika 7 Rad u učionici na SWOT analizi

The next step was to adjust content to micro location. So, for example, the object near the village with its gastro-offer of the local resources supported the development of micro location and became a point on the route which provides consummation. Other contents were distributed on other locations in the same way. The following contents are anticipated: inn with a horse-stable, multipurpose room for gatherings (NGOs, groups' et al), museum and souvenir shop, a restaurant, a wine house, a hotel and a cycle repair service.

The last step was to set a concept of rebuilding considering the shape of the object. Severally devastated buildings were revitalized by modern technical solutions, while objects in good condition were modified in a way that current condition stays as original as possible.

The principles we used in pre-modifying differed according to the groups: from keeping and promoting the original condition of the object (in village Širine), to maintaining the minimal structure characteristic for the typology (Zmajevac) (Figure 8). With such input, we set the notion solutions of modifying the buildings, with a suggestion for interior design. At the end of the semester, seven notion solutions served as menu for defining seven railway stations.

Within the subject Masonry Structures the review of wall and ground quality as a whole was made. Students



Figure 8 Different approaches - new building in the old one and preserving the current situation, stations in Kneževi Vinogradi and Širine
Slika 8 Različiti pristupi – novo u starom i zadržavanje postojećeg stanja u Kneževim Vinogradima i Širinama

established the type of construction of the building, the arrangement of supporting walls and the type of wooden roof construction. By digging the ground, they also established the depth of foundations.

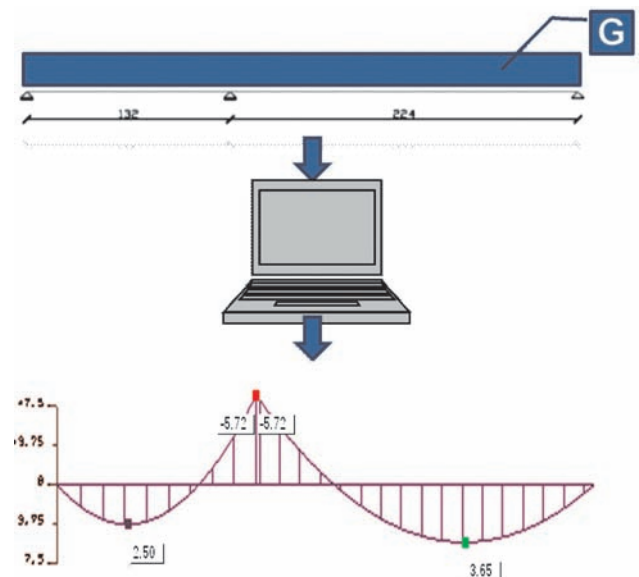


Figure 9 Static calculations
Slika 9 Statički proračun

The supporting walls of all buildings were examined, possible openings and damages as well. All the buildings were firmly constructed, preserved with all relevant supporting parts. Lack of hydro isolation and inadequate maintenance were notified as a defect. In order to combine and enlarge rooms within the buildings, students opted for making openings through certain chosen walls, along with putting up horizontal beams. Static calculations, usability and supportness were proved well and accurate. Based on development notion projects and constructive solutions within the subject Construction Management, students elaborated technical descriptions for object renovation, calculation of the quantity of all types of works, and the analysis of prices as a basis for financial budget for renovation and re-use.

As expected, the biggest part of expenses referred to preparation works (deconstruction, removing mortar from outer and inner walls, uncovering), building and carpenter's works, due to the nature of intervention and a need for conversion of the objects (Figure 10). Recovery works on

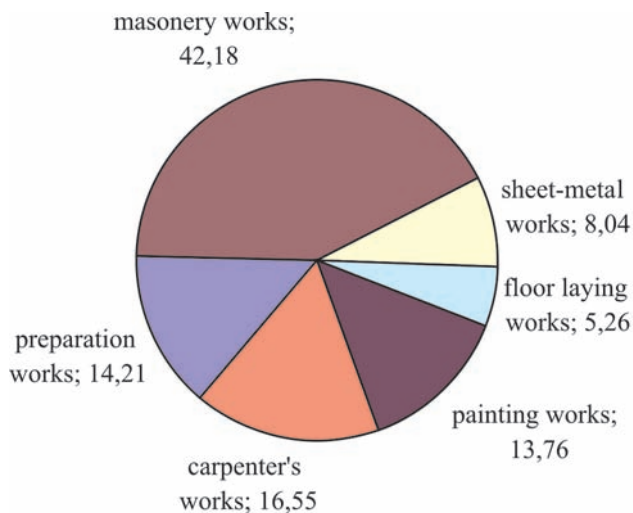


Figure 10 Renovation cost structure
Slika 10 Struktura troškova sanacije

object consisted of complete change of the roof construction, cover and roof tin, reconstruction of the front, as well as inner walls and floor renovation (inner walls mortar works and renovation or change of floor surfaces). According to the financial budgets, average costs of renovation amounted to around 27500 € for 190 m². Finally the task included a survey of the dynamic plan of renovation.

4

Students' Workshop Evaluation

Studentsko vrjednovanje radonice

After the completion of the workshop, a poll was conducted with the goal of getting the feedback from the students on the positive and negative aspects of the project. The poll was conducted by the teachers that moderated the workshop. Out of twenty students that took part in the workshop, fourteen turned in completed questionnaires.

In grading the contents, results and organization of the workshop students had three options: not satisfied (1), satisfied (2) and very satisfied (3). The contents were graded 2,57 (out of maximum 3), the results were graded 2 and the organization was graded 2,14. In grading the workshop as a whole, students had five options ranging from the worst (1) to the best grade (5). Overall numerical grade of the workshop was a respectable 4,62 out of a maximum 5.

Positively evaluated aspects of the workshop included the contents of the workshop, its combination of field and classroom work, regional issue that was dealt with, interdisciplinarity, team work and autonomy in completing given tasks. Suggestions were made in the direction of augmenting the time for consultations and enhancing coordination between teachers.

5

Conclusion

Zaključak

Students' workshop "Where the railway is?" had two main aims; one was to adapt and incorporate contemporary educational tendencies and techniques into curricula at the Faculty of Civil Engineering of the Josip Juraj Strossmayer University of Osijek and the other was to promote socially

responsible interaction between the Faculty and its environment.

The educational aspect of the workshop was conducted based on the student and outcome oriented approach to learning, reinforcing students' abilities to function on multi-disciplinary teams, understand professional and ethical responsibilities, communicate effectively and have a knowledge of contemporary issues. To achieve these goals a concept of Problem Based Learning was adopted.

The social aspect was reflected in the choice of the problem area and the problem itself. Students' hard work on designing a solution to a real and complex question resulted in promotion of the extensive but frail architectural and cultural heritage of Eastern Croatia; students presented their achievements on several occasions in Croatia and Turkey.

The workshops' results, organization and impact were evaluated after its completion by its participants. The workshop was graded with an overall high mark (4,62 out of 5) and the students praised interdisciplinarity, combining field and classroom work and tackling regional issues while stressing the need for additional teacher-student consultations. A general remark expressed by most of those involved was the need to conduct more similar activities in the future.

6

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