

Razvijanje mehkih znanj na tehničnih fakultetah: izkušnje s študentskim delom na projektih

Developing Soft Skills for Engineering: Experience With Student Team Projects

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Povzetek

Medtem ko si sodobne tehnologije počasi utirajo pot v izobraževalne programe na vseh nivojih, ne smemo pozabiti tudi na razvijanje sposobnosti za uspešno uporabo teh tehnologij za reševanje kompleksnih problemov v sodobnem svetu. Članek predstavlja obetaven način pridobivanja kompetenc za delo v interdisciplinarnih projektnih skupinah. V predmetu »Skupinski projekt« na bolonjskem magistrskem programu Gospodarski inženiring študentje pridobivajo izkušnje in razvijajo sposobnosti timskega dela, koordiniranja, projektnega vodenja, raziskovanja, reševanja konkretnih problemov, predstavitev rezultatov javnosti in upravljanja s časom. Predmet je na programu v prvem letniku kot obvezna sestavina študijskega programa. Študentom nudi konkretno izkušnjo projektnega dela, podobnega tistemu v realnih poslovnih okoljih. Preizkusijo se v interdisciplinarnem timskem delu, pri čemer morajo premagovati negotovosti in težave, ki se pojavljajo pri tovrstnih projektih. Po prvih izvedbah se je nabralo že več izkušenj, s pomočjo katerih izboljšujemo izvajanje predmeta. Kljub temu še vedno predstavlja precejšen izziv tako za študente kot za profesorje.

Ključne besede: skupinsko delo, študentski projekt, gospodarski inženiring

Abstract

While advanced technologies are entering schools at all levels, we claim that other skills needed to deal with them in a complex nowadays world should not be neglected in the education system. In the article a promising approach to the interdisciplinary post graduate education is described. The idea of the »Team project« course is to give the students opportunity to gain experience with an extensive project where different skills are needed, e.g. team work, coordination of work, project management, research, problem solving, public presentations, time management. The course is obligatory and held in the first year of the master study program at the School of Engineering and Managment of the University of Nova Gorica. The main advantage of the course is to give the students hands-on experience of the work on a project

which is very close to the reality. Students are forced to gain the experience in team work, and to overcome the uncertainties and obstacles which arise in such projects. Since the launch of the course several improvements were made with the aim to improve the performance of the course. Nevertheless, the course remains a challenge for students as well as for teachers.

Keywords: team work, student project, engineering and management

1 Introduction

Solving problems in nowadays complex world requires a lot of knowledge, creativity and collaboration. In education system, the prevailing emphasis is on knowledge. To prepare students for difficult challenges of tomorrow, just bringing more »ready-to-use« knowledge into the process might not be sufficient, because the amount of ever-changing specialized knowledge is too big. Therefore, it is important to teach students how to acquire newly developed and dispersed knowledge by themselves and equip them with knowledge technologies to support them in this process (Urbančič, 2007). It is also becoming an imperative to bring knowledge and creative potentials of individuals together through team work. The concept of network intelligence as the capability of going beyond fixed individual identity through dialog, mutuality and trust (Palmer, 1998) is becoming more and more important. Consequently, the aspects of creativity and collaboration should gain importance also in education (Burns and Jordan, 2006). Therefore it is not surprising that training in communication, networking and team-work is explicitly listed among necessary improvements as suggested in the proposal of the European Commission on how to modernize Europe's universities (Europa Press Release, 2006).

In engineering study programmes, the prevailing emphasis is of course on engineering knowledge and skills. Besides highly specialized individuals, industry and other employers need also professionals with capabilities of connecting technological, economical and organizational aspects needed for success of an enterprise. It is a big advantage for engineers to understand the connection between technical solutions and their economic aspects, and also to be prepared to work in interdisciplinary teams.

One of the study programmes preparing students for this kind of jobs is also Engineering and Management at the University of Nova Gorica. Lack of this profile may be indicated by the fact that employability of graduates at this programme in one year after graduation is over 96%.

Several good examples of introducing team-work projects into schools are known. Early ones were mostly from the United States where also some very successful forms of it have been developed, such as d.school, originated at the Stanford Institute of Design (<http://www.stanford.edu/group/dschool>) and being introduced also in Slovenia through the activities of Faculty of Economics at the University of Ljubljana. When designing team project work for students of engineering and management at the University of Nova Gorica, we were inspired by team projects as carried out at the International Space University (<http://www.isunet.edu>). Main elements of the course are learning by doing, combining knowledge from different backgrounds, foster creativity and in the first place, experience problem-solving and decision-making in an interdisciplinary team.

2 Methodology

The course »Team project« has been launched in academic year 2006/2007. First the theme of the work has been defined. Academic staff of the University of Nova Gorica was asked to give suggestions for the goals of the project. Out of all submitted suggestions »Alternative use of aluminium« was chosen as the theme of the project.

The goals of the project were as follows:

- to propose the new ways of use of aluminium,
- to prepare a business plan for the new ways of aluminium use for potential investors,
- to present the business plan to potential investors/users.

In the course 24 master students participated. The participating students had different graduate background (4 engineering, 20 engineering and management). All of them were employed and had on average more than two years of working experience. The course lasted for 18 weeks, and the project was divided into 5 phases. Project plan is depicted in the figure 1. In the first phase, an overview of aluminium production and usage was given to the students. During the phase a field trip to the aluminium production plant and aluminium processing plant was organised, and literature overview was presented to the students. The phase lasted 1 week. In the second phase, students were divided into four groups. During that phase each group conducted a study with current state of the art in the field of aluminium use and prepared 3 ideas for the alternative use of aluminium in the future. The phase lasted 5 weeks, during the time students held regular meetings once per week. They used different team work and problem solving techniques: brainstorming, weighted voting, Pareto analysis, etc. After the second phase each group prepared a short presentation of 3 potential use of aluminium in the future. The third phase lasted 2 weeks. During the phase all participating students met 2 times. In the first meeting each of four groups from the second phase presented their 3 ideas for the alternative use of aluminium in the future. In the second meeting 2 ideas were selected out of 12 presented ideas for the preparation of detailed business plan for potential investors. During the meeting different decision making techniques were used, e.g. definition of selection criteria, weighting of the criteria, group voting. Fourth phase lasted 8 weeks. The purpose of this phase was preparation of detailed business plan for two selected ideas from the third phase. During the phase students were divided into 2 groups, each of the two groups was then further divided into 4 subgroups. Each of the 4 subgroups in each group prepared one section of the business plan: market aspect, financial aspect, technology aspect and environmental aspect. At the beginning of the phase four experts in the fields of marketing, business finance, materials, and environment gave students an overview of their fields and guidelines for the preparation of respective sections of the business plan. During the whole phase the students had opportunity to consult the experts. In the fifth phase, two groups prepared a final business plan and presentation for potential investors. The presentations were given to invited faculty staff.

Phase	Duration (weeks)	Groups and description of work				Output and comments
1	1	Overview of aluminium production and use, field trip to aluminium production plant and aluminium procession plant				Output: general knowledge of aluminium use as basis for further work
2	5	Group I.1: research and preparation of 3 ideas for alternative use of aluminium in the future	Group I.2: research and preparation of 3 ideas for alternative use of aluminium in the future	Group II.1: research and preparation of 3 ideas for alternative use of aluminium in the future	Group II.2: research and preparation of 3 ideas for alternative use of aluminium in the future	Output: 12 ideas for alternative use of aluminium
3	2	Group I: Selection of one idea for		Group II: Selection of one idea for		Output: 2 ideas of alternative use of aluminium
4	8	Group I.3: environmental aspect	Group I.4: technology aspect	Group II.3: Environmental aspect	Group II.4: technology aspect	Output: 2 business plans for alternative use of aluminium
		Group I.5: market aspect	Group I.6: financial aspect	Group II.5: market aspect	Group II.6: financial aspect	
5	2	Groups I and II: preparation of final reports and presentation to potential investors				Output: 2 presentations of business plans for potential investors

Figure 1: Project plan of the course »Team project« in the academic yera 2006/2007

For the second time the course »Team project« was conducted in the academic year 2007/2008. In the course 17 postgraduate students participated (out of them 10 students finished engineering graduate schools and finished 7 engineering and management graduate schools). Also in this generation, most of the students already had at least two years of working experience. The business plan for the usage of a water source near Ajdovščina was chosen as the theme for the project. The course lasted 8 weeks. Students were divided into 3 groups. Each group worked on preparation of one aspect of the business plan: marketing, technology, and finance. During the course students had 10 scheduled meetings. Project plan is presented in the Figure 2. In the course four tutors/consultants were available to the students: one industry expert with problem solving and project management skills, one industry expert in marketing, one industry expert in project management and finance, and one industry expert in the field of water treatment and water filling technology. During the course each involved expert held an intrductory lecture in its field of expertise. In addition to that, students were given one lecture in the field of final report preparation and public presentation. During team work the teams had opportunity to consult each expert three times (see Figure 2). In the last session the business plan was presented to a broad audience consisting of university staff, participating experts and invited potential investors. The students prepared also official final report with detailed business plan, which is available in the university library (Bizjak et al., 2008).

Session	Weeks passed	Description of work	Experts present
1	0	Introductory lecture: team work, problem solving, presentation of the theme, instructions for work, definition of groups	Problem solving
2	1	Introductory lecture: project management, business plan	Project mngt and finance
3	2	Introductory lecture: water filling technology, team work	Water filling technology, problem solving
4	2	Introductory lecture: marketing plan, team work	Marketing, problem solving
5	3	Team work	Project mngt, problem solving
6	4	Team work	Problem solving
7	5	Introductory lecture: public presentation, team work	Presentation, problem solving
8	6	Introductory lecture: report writing, team work	Problem solving
9	7	Team work	All
10	8	Final presentation	All

Figure 2: project plan of the course »Team project« in academic year 2007/2008

3 Results

In the academic year 2006/2007 the students prepared two business plans for different alternative ways of using aluminium. First idea was do-it-yourself glass pavillion, which would have the following characteristics: light weight, low cost, flexible, expandable, ready for self-construction (Stokelj et al., 2007). The second idea was a light and flexible greenhouse, with the following characteristics: light weight, flexibility, modularity, multifunctionality, includes also watering function, which brings additional added value for the users because no additional watering system is needed (Boškin et al., 2007).

In the academic year 2007/2008 the students prepared one business plan for the idea of water filling at the Source Skuk near Ajdovščina. The main idea of the business plan was to create some extra value to the bottled spring water. It is known that there is large competition in the bottled water market segment. Therefore the students created an innovative idea for a brand called »Fortuna«, addressing human desire for good luck and aiming to attract people looking for it at specific places, including casinos.

After the course students were asked to fill a feed-back questionnaire. The main positive comments of the students were related to the work in teams, informal communication and socialisation with their colleagues, and final presentation of business plans.

Students' main complaints were related to the themes of the project (students would like to choose their own themes for the project work), managing of the project

(students would like the project to be managed by the professor and not by one of them, or at least the organizational structure of the project to be arranged by the professor), scheduling (student would like to have the course in the second year of the study, the atmosphere would be more relaxed due to better social relationship among the students) and lack of analysis of problems and experiences accumulated during the project.

4 Discussion

The idea of the »Team project« course was well accepted by the students and teachers. From the experience to date we can conclude that the course achieved its main aim – expose the students to the work on complex projects. The students, who passed the course, gained useful experience in research work, interdisciplinary team work, project management, problem solving, presentation of business plans, and other »soft skills« needed in such projects. Even students' complaints mentioned above actually indicated that the course succeeded in providing a simulation of a real situation, including typical problems with catching dead-lines, taking personal responsibilities towards the team, learning about completely new things, looking for solutions without being told directly how to do it. It is important for students to have such a training in a sufficiently complex, interdisciplinary and »almost real«, but still controlled and safe situation.

During the courses also teachers gained precious experience with interdisciplinary work of students. The main lessons learned could be summarised as follows.

- Crucial elements of the project should be well defined in the beginning of the course, especially goals, time frame, phases, goals for each phase and milestones.
- In the first execution of the course the theme was rather difficult to understand for most of the students. While this offers an opportunity for students to develop skills of grasping completely new technologies, themes and problems, it might require too much effort, regarding the fact that available time is rather limited. If the main goal is to develop skills of team work and project management, the theme of the project should not be too complicated.
- The structure of the project should be as simple and logical as possible. In the first execution of the course we planned too many phases and too many group reforms.
- During the course regular meetings should be scheduled. Too long periods between meetings dilutes the effort.
- Not too much other obligations for the students should be planned in the time of the team project. In the first execution of the course the students had two other courses running parallel to the course which distracted their focus.
- The length of the course should be no longer than 10 weeks. This enables the right focus of the students and is close to the usual time frames of the mid-complexity projects in real business life.
- In some engineering studies, there is not much emphasis on presentation skills. Therefore, instructions and guidelines for the preparation of final report and presentation should be provided.
- Students were not very active in seeking help from the provided external experts, although this might be very useful. The role of experts should be promoted.

- Students like using easy-to-use templates, such as templates for project plan, reports, minutes of meetings and other deliverables, which are created during the execution of the project. The use of templates leaves more time to be spent on other, more important tasks and objectives.
- It is important that students are well informed about the objectives of the course in advance. It is also crucial that there is some time scheduled for discussions and analyses of problems, experiences and lessons learned, which should be also summarized in a final discussion after the final report is given.
- Students prefer to be given specific instructions and want the team to be managed by the teacher. However, too much instructions and external control contradicts one of the important objectives of the course, which is also development of self-organizing skills, personal initiative and responsibility. We believe that finding an appropriate balance in this respect is crucial for the success of the course.

In general we can conclude that the »Team project« course brings added value to the study program by developing several important skills that can not be obtained through the usual »Ex catedra« learning style. In the future some additional refinements to the course will be done in order to make it even more effective. However, no matter how successful such single courses at the university level might be, we strongly believe that development of skills needed for team work and for »open« problem solving without direct instructions and recipes should be supported through the entire education at all levels.

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