Teaching Project Management in Academic ICT Environments

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Abstract—Project management helps accomplish the common purpose of a project with defined requirements and desired quality. Teaching project management for graduate and undergraduate students requires combining optimal foundation in theory with maximal usability in practice, as well as project management tools support. Finding an optimal balance between theory and practice, and motivating students to broaden their understanding of the PM area is an exciting and challenging task. If successful, students’ research projects may yield attractive outcomes. This paper presents our experience in a PM course and illustrates the resulting student projects.

Keywords—project management, teaching, student experiments, education methodology.

I. INTRODUCTION

A project is a temporary endeavor undertaken to create a unique product, service, or result [1]. Although basic awareness of what the project represents exists, real-life research studies have show that the overall understanding of project issues often isn’t very thorough. The study [2] from 2003 shows that project success rates account for 34% of all projects. 15% percent of all projects fail, and 51% are considered challenged. Although these numbers have improved with respect to similar studies from 1994, there is still plenty of room for improvement.

In order to improve overall project success rates, it is imperative to have domain experts in teams, but also to have people familiar with project management (PM) principles. This was a guideline used to introduce a Project Management course for upper-undergraduate students of both electrical engineering and computing, with the intention of building their competence in the areas of project management basics and practice.

The goal was that students acquire knowledge regarding formal project definition, teamwork and the common life cycle processes of a project. Students were meant to obtain a good understanding of the prerequisites for successful project management, with an emphasis on project domain [3], business environment [4] and communications aspects [5]. The final goal was to obtain a theoretical basis and practical skills, and to participate efficiently in teamwork. This would prepare them to successfully carry out different roles in industry projects.

In order to prepare this course with the desired quality and maximum benefit, we decided to conduct some preliminary research regarding students’ readiness to participate in teamwork. This is described in section II. Section III describes the Project Management course, and section IV analyzes student projects. Section V emphasizes the use of software tools to manage projects. Sections VI and VII represent results of two projects that were directly used to improve the course quality, and section VIII concludes the subject of teaching project management in academic ICT environments.

II. STUDENTS’ TEAMWORK EXPERIENCE

Today, teamwork is an inevitable part of successful project management, particularly for large telecommunication software development projects [6]. Project management is mainly team management, but also time management, money management, etc. While designing the Project Management course structure, with the aim of acquainting students with the advantages of teamwork and the associated risks, we organized student projects in such a way as to allow students to plan, monitor and work on the activities for a certain time period, producing high quality project outcomes.

To investigate different teamwork aspects among undergraduate students, we conducted a short research experiment at our Department. The goal was to formally analyze students’ experiences while working in a large team (where teamwork problems become more visible). Research was conducted on a group (N=56) of fifth year students participating in a software engineering course.

The students were divided in two equally-sized teams and both teams were supposed to solve identical tasks in the area of known student business processes. One team had assigned a team leader whose responsibility was to organize subtasks, as shown in Fig. 1, while the other team was free to apply democratic team organization.

![Fig. 1. Communication paths inside teams with: a) an assigned team leader, b) democratic organization. Solid lines represent usual paths, while dashed lines represent unusual paths.](image-url)
Both student tasks were related to student business process, such as teaching improvement or student canteen efficiency, and demanded a written and graphical solution proposal within two weeks. The teams were given a template to help document their solutions, describe the teamwork aspects encountered (along with their advantages and limitations), and discuss the team organization applied.

The research was focused on the teams’ communication and collaboration, subtask coordination, the process of decision making, etc. The results were qualitatively evaluated and are summarized below. According to the results, the experiences of the team with an assigned team leader were as follows:

- Inter-team communication was strictly virtual (e.g. by e-mail) and only conducted with the team leader, with clearly defined and assigned subtasks,
- Faster decision making and less responsibility for team members, with no practical insight into other team members’ progress,
- Non-democratic relationships inside the team, with one-man decision-making leading the process of finding the solution.

The teamwork aspects in the team without an assigned leader can be described as follows:

- direct and heterogeneous communication (e.g. by SMS, e-mail, live), with more democracy inside the team,
- difficult subtask definition and delegating, communication sometimes confused,
- Less motivated team members without clear leadership, no exact supervision of roles and responsibilities.

From these experiences, we concluded that students do not find teamwork odious, but due to their lack of experience, would rather have some form of leadership with clear and precisely defined tasks. Consequently, we decided to act as stakeholders and partly manage student course projects ourselves, but also have project team leaders for each student team to bear some responsibilities, manage tasks, etc. The authors of this paper later dealt with the teamwork issues by implementing a tool for improving virtual team communication [7].

III. PROJECT MANAGEMENT COURSE DESCRIPTION

The Project Management course was introduced to our Faculty for all fourth year students (upper-undergraduate) in the academic year 2004/2005. Due to the broad applicability of project-based work and development in all fields of electrical engineering (EE) and computing, this course was offered as an elective to students enrolled in any graduate study programme at the Faculty.

During the introductory year, significant efforts were made to establish a laboratory environment for practical student exercises in project management. In 2005/2006, the emphasis was on taking advantage of high-quality student projects to improve the course itself.

A. Lectures

Lectures cover the project and project management basics. The lectures are divided into two segments. The first segment covers fundamental theory regarding project definition, project management discipline, characteristics and examples of successful projects and project failures. Students learn about the project life cycle process and planning techniques, the role of a project manager and the profession itself. The lectures also cover negotiation, communication and conflict management. Project management tools, as well as the aim of project documentation, are presented within this core project management theory.

The remaining lectures are composed of invited talks held by recognized project management professionals from different segments of industry, as advised in [8]. The ratio between fundamental theory lessons and invited talks is 2:1. Invited talks mostly illustrate industry projects, mapping theoretic principles to real-life situations. Each year, a new set of invited topics is offered. So far there were topics about: managing the projects of system integration, project management as a career, human resource management, establishing a project management office for an international company, and invited talks describing different examples of projects, such as software development for mobile telephony and a civil construction project for building a business tower. Invited speakers are mostly from recognized IT companies (IBM, Ericsson, Siemens, Microsoft), and from civil construction companies. In a final ‘satisfaction survey’ given at the end of the lectures, students express their satisfaction with the way theory is illustrated through the invited talks.

B. Projects

An important and practical part of this course is student projects. At the beginning of the term, an initial list of project proposals containing short descriptions and explanations of the projects’ purpose is presented to the students. They are also encouraged to propose their own projects, and those provided from real customers [9]. Project teams are composed of 4-10 students, and they are free to choose any project they are interested in. Unlike the approach in [10] where the team leader is rigidly selected, each project team appoints its own project leader. The project lasts seven weeks. The result (deliverable) of the each project is clearly defined and should be visible at the end of the 7-week period. The deliverable is either a piece of software or a written study.

While working on the project, students are also obliged to fill out the given project documentation: the Project Charter, Project Plan, Revised Project Plan, and Project Closure documents. The form of documentation is defined by adapted templates divided into chapters that need to be completed with information regarding the particular project. Students should plan their activities, make work breakdown structures (WBS), network and Gantt diagrams, determine project milestones, and identify and manage project risks. All team members should take part in the planning activities, while the project leader is responsible for controlling and coordinating all these activities. The project team should meet regularly, and all student project leaders should have regular meetings with lecturers, discussing the hot topics concerning their project. Students are encouraged to work iteratively and to monitor project progress through the validation of the
determined project milestones which should be clearly visible.

IV. ANALYSIS OF STUDENT PROJECTS

Within the Project Management course, in the past two academic years, three main types of student projects were identified:

- Software development projects,
- Software implementation projects, and
- Research study projects.

Software development projects result in complete software applications, ready to accomplish a given purpose. Previous projects include: the Result Messenger, Project Web-registration, Multimedia presentation of the PM course, PM agent development (as illustrated in Fig. 2), etc. Specifically, the project called “Project Management Agent Development” [11] resulted in an implementation of a mobile software agent (based on the JADE platform), which was able to manage specific project plan changes and inform project members about the changes. The agent was designed to strictly follow activities described in the detailed workflow of the business process it supported.

Next, software implementation projects result in appropriate IT- or ICT- solutions for a given purpose, using known technologies. Examples of these projects include: Implementing .NET security, Content management systems (CMS) functional analysis, Electronic territory management system (ETMS) implementation for a pharmaceutical company, Web tutorial for Internet beginner users (as shown in Fig. 3, written in Croatian), etc. To illustrate, the “Multimedia presentation of Project Management course” project resulted with the creation of a detailed website in two versions (pure html and flash) containing information for students regarding the course structure, literature, grading system, course staff, and even two video clips presenting the course in a serious and funny manner.

Finally, research study projects result in detailed written studies on a given subject. Examples of previous research study projects include: Lawful interception in telecommunications, Electric power world market analysis, Non-governmental association setting-up process analysis, e-Croatia etc.

Specifically, the project called “e-Croatia: Implementation of IT Strategy in Croatia” resulted in seven detailed studies with documented field responses (survey, interviews) from areas included in the main IT strategy, such as education or healthcare. The results were presented via a website with multimedia additions, shown in Fig. 4, and written in Croatian.

In academic year 2004/2005, 83 students participated in 14 projects, of which 5 were development projects, 2 were implementation projects and 7 were research studies. In the following year, the number of projects for 123 students increased to 17, with 7 development projects, 3 implementation projects and 7 research studies.

Fig. 5 shows the distribution of project types for these two years. There was a noticeable growth in the areas of development and implementation, but the number of research studies fell. This is reasonable behavior since students from all fields are more and more aware of the applicability of ICT technologies to their fields of study, and would like to perform projects of their own, to gain practical knowledge and experience.

V. TOOLS FOR PROJECT MANAGEMENT

Besides the theoretical part of the course, there were two practical parts. The first practical part was to apply the theoretical knowledge learned at lectures by participating in and managing a student project, as presented in the previous section. The second practical part was to learn to use a professional project management tool to ease the first practical part of the course. The latter part was in the form of laboratory exercises. In this section we will explain how the exercises were carried out.

We think that it is increasingly important for students to work with professional project management tools. Everyone would agree that actually working with a tool is much more helpful than just seeing it or listening about it. In addition, we assumed that it is easier to understand the theoretical part of a course when it is combined with practical, hands-on work in a laboratory.

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With laboratory exercises, we wanted to achieve two very important goals: help our students to finish their projects more efficiently and teach them to use a professional project management tool. Today, it is hard to imagine that even the smallest company functions without using at least one of these tools. We think that this knowledge will give our students a starting advantage in their professional careers compared to their competitors [12].

Our previous experience has shown us that students understand lectures (i.e. theory) much better if they have some kind of a practical work, and even more if they have adequate laboratory exercises [13]. Thus, we decided that laboratory exercises would be a compulsory part of the course.

Since the course was an elective for students attending many different study programs, it seemed impossible to find fixed schedules for the exercises. Thus, we decided that we would not control the time spent by students in the laboratory. Instead, we only controlled the results of their work. The exercises were done in computer laboratories at the Faculty, where students could work at any time during working days.

First, we had a long debate as to which tool we would use for the exercises. Two of the strongest candidates were Microsoft Project and Open Workbench. We will not compare these tools here since it is not a purpose of this paper. We have to admit that both tools are very good, but we decided to use only Microsoft Project. Open Workbench has only a desktop application version while Microsoft Project has both a desktop application and server version.

The main reason why we chose Microsoft Project was its server version. Having a server version of Microsoft Project proved to be a very useful, allowing students to access their work from different computers and laboratories. In addition, it was easier for us to help them when needed and to control their work progress. Fig. 6 shows the actual configuration of the tools in the laboratory setting.

Because we have three well equipped laboratories, the only expense we actually had was a price of a new server. We installed Microsoft Project Server 2003 on the server, and Microsoft Project 2003 on the PCs in the laboratories.

Herein, we will say few things about the actual laboratory exercises. As we mentioned before, each team was composed of 4 to 10 students. A team had to accomplish the following tasks in the laboratory:

- Creating a new project,
- Defining tasks in a project,
- Allocating resources to tasks,
- Storing a necessary documentation to a repository, and
- Communicating about the progress of a project.

We provided them with user manuals containing detailed instructions for setting up the tool and accomplishing each task. At the end of the course, each student was able to finish these tasks independently in a laboratory.

Upon completion of the course, a few students proposed we make a slight change in the laboratory exercises for next year by allowing students to access the server from their homes. We have decided not to allow this because of the configuration of the fire-walled network in our student laboratories shown in Fig. 6.
It is important to note, however, that the students actually could work at home - they simply needed to download the project from the server first, work on it at home as desired, and then upload the new version back onto the server. The download and the upload could only be done from the student laboratories and not from their home computers.

VI. E-LEARNING STUDY

The goal of this research project was to investigate the possibilities of conducting part of a course with an appropriate e-learning tool. Comparative analysis was conducted between three software solutions offered for the course:

- Mambo open-source CMS – empowering our Department of Telecommunications website,
- FER CMS – empowering our Faculty of EE and Computing website, and
- WebCT – e-learning solution integrated into our Faculty website.

Mambo CMS is an open-source solution, free to use under the GNU/GPL license. FER CMS is a proprietary solution of our Faculty, developed by employed professionals. WebCT is a widely used open-source/commercial hybrid solution. The comparative analysis took into consideration only the actual functionality setups that were already being used by the given solutions, and not the possibilities of extending these functionalities with additional components and plugins. The comparison is given in Table I.

Results of the study show a significant advantage of the WebCT solution over the other two content management systems, especially in adequate support for multimedia presentations and student grading. This research study was meant to determine which solution to use for course realization in the next academic year.

VII. E-EXAM TOOL

This section describes a student software development project, the deliverable being a software tool called e-Exam, for online testing and grading students. Functionality of the tool includes a Web interface enabling students to take exams from different courses in different timelines at different places. Exams are generated from the questions database for each student separately. Thus, if the database contains a large number of questions, the possibility of question repetition is minimized.

A. Functionality and Software Architecture

The Web-tool offers functionality for three types of users: tool administrators, course teachers and students (course attendees).

The tool administrator has features enabled such as adding, editing and deleting courses, teachers and students. Files with specially formatted (character-separated value) teacher and student data can easily be uploaded and managed. Course teachers are offered features according to the three levels of privileges for the courses they are dedicated to:

- Level 1: exam results overview and excluding students from exams,
- Level 2: all level 1 privileges as well as the privilege of grading exams, and
- Level 3: all level 2 privileges along with adding and editing exams (e.g. adding and editing questions).

Each exam is defined with a specific name, date and time of execution, duration, password, number of questions, and exam type. Possible exam types are: blitz-quiz and preliminary exam. The main difference is that blitz-quizzes are composed of questions with a certain percentage from each predefined group of questions (e.g. lecture subjects), while preliminary exams have questions grouped by specific student groups (e.g. student group A).

Teachers with privileges to grade exams are offered two means of grading:

- Grade by student – grading one exam at the time, with or without the option to compare it to an already graded exam on the Web interface, as shown in Fig. 7 (in Croatian), and
- Grade by question – grading one question at the time from each exam for all students that participated in the exam.

Students are offered features enabling them to see which exams are currently available for execution in the courses they are taking, which exams are finished and graded, and which exams will be available for execution in the near future. Students can take available exams only when the teacher provides them with the corresponding exam password. Since each exam is time-limited, information regarding elapsed time is given to students via their Web-interfaces throughout the duration of the exam.

B. Tool Verification and Trial Work

The e-Exam project was successfully completed within seven weeks, as shown in Fig. 8. After the tool was developed and tested by the student team, the next step was to use it for a trial period. The trial was scheduled for one business week in May 2006. First, we installed and tested the tool for use in our Department laboratory, and then simulated online exam-taking for a small student group (N=27). The simulation was aimed at checking the application’s stability and robustness during online exam-taking.
The results were satisfactory, and the tool was shown to be robust for different kinds of unpredicted user actions, without causing damage to data or application stability. Therefore, we decided to use the tool to conduct preliminary exams for 130 students in our Project Management course.

We filled the tool’s database with a sufficient number of questions, not only from the course lectures and project management theory, but also from the practical work and project management tool usage.

The trial took place in three laboratories at our Department, equipped with 10 to 12 computers each, in four 30-minutes cycles during one business day. Each group was assigned an assistant who gave specific instructions to students, and provided them with their exam password. During the trial, there was no tool misuse detected. The grading procedure with e-Exam was very efficient and the results were made public the following afternoon. Every student had the opportunity to login again to the tool’s Web-interface and review his/her graded test.

VIII. CONCLUSION

In this paper, we have presented the syllabus implementation for a Project Management undergraduate course according to the four building blocks of project management [14] – people, process, tools and measurements. The goal was for students to efficiently follow the syllabus and successfully accomplish projects according to defined processes, using appropriate PM tools, and allowing us, the lectures, to evaluate and grade their work and results.

A very valuable part of every student project evaluation was critical overview in form of project retrospective [15]. We have conducted for each student project. Along with the usual project documentation, we tried to get an overview and collect all information regarding various project aspects publicly in front of the other team members, in order to retain their integrity and respect of others. This even included a student self-grading system. Implementation of the procedure was very well accepted by students, who gladly shared their team experiences working on projects with other course attendees for the benefit of the whole.

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Part of this work uses and evaluates results from the e-Exam software project and the E-learning systems adoption study project. These projects were carried out by two ten-student teams and three stakeholders (the authors), within the Project Management course in the upper-undergraduate study program at FER, University of Zagreb, in Spring 2006.

REFERENCES


