The International JOURNAL *of* LEARNING

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VOLUME 12

INTERNATIONAL JOURNAL OF LEARNING
<http://www.Learning-Journal.com>

First published in 2005 in Melbourne, Australia by Common Ground Publishing Pty Ltd
www.CommonGroundPublishing.com.

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ISSN: 1447-9494 (print), 1447-9540 (online)
Publisher Site: <http://www.Learning-Journal.com>

The INTERNATIONAL JOURNAL OF LEARNING is a peer refereed journal. Full papers submitted for publication are refereed by Associate Editors through anonymous referee processes.

Typeset in Common Ground Markup Language using CGCreator multichannel typesetting system
<http://www.CommonGroundSoftware.com>.

A Project-Based Learning Approach for Teaching ERP Concepts

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Abstract: Project-Based Learning (PBL) constitutes a generic, powerful and widely adopted educational approach, especially appropriate to organize and teach ICT (Information and Communication Technology) applications and business management courses at undergraduate level. The article presents how a PBL approach is applied to an Enterprise Resource Planning (ERP) graduate-level course that is offered in the programme of studies of a project management department. The primary objective of this application is to allow students to improve their cognitive, collaborative, methodological and technical skills on ERP systems through active participation in challenging and interdisciplinary ERP projects. Students explore knowledge and enhance their learning on ERP systems by participating in project teams and collaborating to carry out realistic case studies which are met in contemporary enterprises.

Keywords: Project-Based Learning, Cooperative Learning, Enterprise Resource Planning Systems, Project Management education

Introduction

PROJECT-BASED LEARNING (PBL) is a powerful and widely adopted educational approach, especially appropriate to organize and teach ICT (Information and Communication Technology) applications and business management courses (Reeves & Laffey, 1999; Fincher et al., 2001; Janeck & Bleek, 2002; Strand Norman et al., 2004). Being at the same time a teaching and a learning tool, PBL provides students with experiential learning opportunities in order to actively develop their knowledge and improve their experience. Students learn and practice cognitive and interpersonal skills, as they work in group projects, cope with complex, real world issues and practices and produce carefully designed products (Lerner, 1995; Bowen, 1998).

PBL can be combined with conventional lecture-based teaching approaches as well as applied computer exercises. However, it shifts the emphasis away from traditional teacher-centered approaches to student-centered teaching and project-based, cooperative learning. PBL aims to develop and evaluate short or long-term student projects. A typical implementation has the same duration as the regular period of an undergraduate semester course (14 weeks) and ends with the final project result (deliverable) that can be a software product, a technical report or a multimedia presentation, which demonstrates the degree of learning assessment of students' teams (Druit, 1995; Moursund, 1999).

Undergraduate students usually have little or not at all working experience. Thus, an important factor that influences the success of PBL implementation, especially into information technology and business

management courses, is the degree that the established conditions of collaborative, project-based learning simulate the nature of real working conditions and procedures of today organizations/enterprises (Kay et al., 2000; Shtub, 2001). The nature of the work within most modern organizations is moving from individual assignments to team and project-based activities (Siegel, 2000). Today, business environments constantly require from their employers to be adept individuals, life-long learners with a willingness to learn, self-directed experts with a continuous interest in enriching and refreshing their domain specific knowledge as well as competent professionals with good leadership and team skills (Wegner, 1998; Shapiro & Levine, 1999). PBL can be proved a very suitable approach to prepare undergraduates for their professional life, when as individuals will consider learning and cooperative working as major parts of their work duties.

This paper describes how PBL is applied to the Enterprise Resource Planning (ERP) course in the curriculum of the Project Management Department (PMD) at the Technological Education Institute of Larissa in Greece. PMD aims at promoting knowledge and practice in PM. The PMD curriculum structure consists of an 8-semester program of studies. Courses offered cover both theoretical and practical background on the nine knowledge areas of PM, as they have been described from the Project Management Institute into the Project Management Body of Knowledge - PMBOK (PMBOK, 2000). These areas are: (i) project integration management, (ii) project scope management, (iii) project time management, (iv) project cost management, (v) pro-

ject quality management, (vi) project human resources management, (vii) project communications management, (viii) project risk management, and (ix) project procurement management.

Introducing PBL into an ERP course is further justified by the inherent diversity and the interdisciplinary nature of ERP system concepts as well as the learning requirement from students to develop a broader and deeper understanding of how enterprises work, implement and utilize technology to improve their operations (Joseph & George, 2002). Modules of an ERP system reflect functions of business processes. Therefore, the “state of the art” and the integrated technology of modern ERP systems make them an appropriate vehicle to meet educational needs in a variety of business and ICT courses, through implementing an integrated curriculum based on ERP (Lederer-Antonucci, 1999; Becerra-Fernandez et al., 2000; Joseph & George, 2002). In the literature there is a number of relevant studies which propose the use of ERP systems to teach management and ICT concepts (Watson & Schneider, 1999) or introduce practice-oriented teaching techniques to develop ERP technical skills, e.g., simulation-based teaching methods (Parush et al., 2002). This paper addresses the problem of effectively teaching ERP systems and related management concepts from a different perspective. The presented approach examines how to configure an appropriate pedagogy for implementing an ERP course. The choice made was PBL since it complies with the necessary learning requirements of the ERP domain as well as with the disciplines of project management which constitute our department’s subject of studies.

Selecting a Teaching Method for an ERP Course

The learning objectives of an ERP course correspond to general skills which are related to the development of management information systems (Watson & Schneider, 1999; Hawking et al., 2001). These are technical knowledge, personal and interpersonal skills (ISCC99, 1999). However, the integrated nature of ERP systems is the characteristic that differentiates them from other IS. An ERP system integrates most of an enterprise business processes and facilitates information flow and sharing among them. It constitutes of a number of functional modules that are software components supporting the functionality and providing business solutions for the corresponding enterprise subsystems (Shtub, 1999; Kumar & Van Hillegersberg, 2000; O’ Leary, 2002). Typical ERP systems, such as those from SAP, Oracle, Baan and Peoplesoft, include modules for financial management, manufacturing support, human resource management, project management etc.

Therefore, an ERP course gives students a unique opportunity: to realize a global view of how business processes and functional areas are integrated within the enterprise context (Joseph & George, 2002; Richtermeyer & Bradford, 2003).

As far the technical knowledge is concerned, the main learning objectives of an ERP course are to provide students with the ability to (Watson & Schneider, 1999; Joseph & George, 2002):

- describe ERP principles, architectural design issues and relevant business and process models,
- utilize an ERP development environment to develop prototype ERP applications,
- understand and apply procedures to represent, develop, integrate, evaluate and redesign business modelling scenarios,
- explain how ERP systems affect business processes and influence reengineering decisions,
- enhance their knowledge on how enterprises interact with suppliers and customers, set goals, measure performance, create policies, organise and manage their operations and,
- get more familiar with “state of the art” applications in ICT area.

ERP system concepts involve the pragmatic use of technology in real business environments. Therefore, besides technical skills and knowledge, an ERP course is required to give students opportunities to improve their interpersonal, collaborative and communication skills. Furthermore, the interdisciplinary nature of ERP systems requires students to apply in practice personal competencies and improve problem-solving skills such as exploratory searching, critical thinking and decision making (Hawking et al., 2001).

This broad spectrum of learning objectives led us to consider PBL as appropriate teaching discipline to implement the ERP course in the 7th semester of the department’s program of studies. Our primary goal on ERP system concepts by collaborating in project teams to carry out realistic case studies which are met in contemporary enterprises. In addition, we considered the ERP course as an ideal basis to systematically apply and reinforce students’ prior theoretical background in project management and ICT techniques. Taking into account these considerations our teaching model is based on 4 pillars, namely:

- developing technical knowledge through the use of a powerful ERP system (SAP R/3),
- applying in practice PM methodologies based on the subject areas defined in PMBOK,
- improving personal skills by executing in a short time frame complex and demanding projects,
- developing interpersonal and communication skills through team working.

Course Implementation and Schedule

The ERP course lasts for 14 weeks. The number of assigned projects varies and depends on the number of students that have selected the course. Usually the majority of students select this module (up to 60 students). This gives an average number of approximately 15 projects per semester. Projects are announced to students in the beginning of the semester. Our objective is to select decomposable projects in order to help the project decomposition into tasks and the subsequent role-task assignment to students (i.e., task leaders). In particular, projects correspond to the functional areas of an ERP system such as production planning, inventory management, materials requirement planning, production and sales forecasting, customers management, human resources management, supply chain management, financial management etc. Students are asked to set up parameters of the ERP system (SAP R/3) and execute transactions according to different business decisions/scenarios. Integration aspects were covered by asking students to demonstrate and implement simple workflows.

Encouraging students from the very beginning of the semester to be active in their project work and emphasizing on individual responsibilities are two important factors for the PBL effectiveness (Bacon et al., 1999). Accordingly, students are given the responsibility to select by themselves a project theme based on their preferences or background and they are asked to form project teams (4-5 students each). Students have some previous experience in using, for example, project management tools (MS Project, Primavera P3), database management systems (MS Access) and programming languages (Visual Basic and HTML). The decision to keep teams as small as possible is based on the recommendation that forming highly cohesive small groups helps to reduce “free-riding” (Strong & Anderson, 1990). Further, some constraints with regard to group membership are presented to students. Each team is required to select a team project manager and 3-4 students are assigned to be the leaders of the corresponding project tasks. One of the team members is specified to be responsible to take and deliver the meeting minutes to the team project manager. Two of the students (one of them is the team project manager) are required to be the presenters of the project results. Student teams, in turn, are asked to write and submit a 2-3 page report (i.e., a “letter of intent”) in order to justify their project selection, group membership and responsibilities.

The course is complemented with lectures, experiments and practice in the computer classroom and regular consultation meetings with each project team. Two hours per week are devoted to lecture time. The purpose of the lectures is twofold. Firstly, lectures

present to all students the fundamental technical background on ERP systems, such as ERP and business processes overview, planning and implementation issues and tutorials on SAP R/3 architecture and operations. Secondly, during lectures we can discuss with all students together upon formal rules, structure and management issues of their project work. Students are also asked to present in public their difficulties in project work and they are provided with general guidelines on how to carry out their projects.

Two additional hours per week are devoted to introduce students to SAP R/3 through a series of tutorial exercises. As part of their work, project teams are asked to execute representative business scenarios in the computer laboratory by considering the virtual company of the demonstration system IDES (“Internet Demonstration and Evaluation System”) of SAP R/3. IDES is both a demo system and a training tool. It represents a virtual international group company with subsidiaries in several countries. IDES includes data modelling various business scenarios that are designed to reflect real-life business requirements (SAP, 2001).

Usually the pedagogy for integrating an ERP system into the classroom is challenging, particularly given the limited availability of instructional resources and IT support as well as the subject complexity. For example, during the first time that the course was delivered (in year 2002) the intended outcome was only to give students some basic exposure and showing them the “look and feel” of an ERP system. During subsequent deliveries of the course, our focus has been shifted to more “hands-on” approaches, for providing students with a better understanding of how an ERP system supports business processes and executes business transactions. Similar difficulties and experience have been encountered to other universities (SAP for MIT 2001; Richtermeyer & Bradford, 2003). Taking this approach one step further, students are asked to simulate actual business cases scenarios and adapt the functionality of SAP R/3 system in order to reflect real business needs. More specifically, students are asked to adapt business processes by using SAP Business Workflow tools. This choice is taken for a number of reasons, both technical and business related:

- IDES system provides examples on business workflow in a way that can be used by students as study material,
- business process re-engineering is a subject of special interest for business students; further, workflows can be defined with a systematic way,
- SAP R/3 Business Workflow provides tools that allow students to define workflow steps in a graphical way and it does not require any special programming skills.

In general, teachers play the role of Chief Information Officers (CIOs). They are technology consultants/project facilitators. CIOs try to be available on a daily basis in order to provide team project managers with help and guidance. Besides, three advisory meetings are scheduled during the semester with all members of each project team aiming at the better coordination of each project, control of intermediary results content and providing quality consultancy as well. CIOs are also available for all students during lectures and during practice in the computer classroom. Experience from the subsequent implementations of the course implementation has revealed that a great part of the technical knowledge on ERPs is provided to team members through the project team managers. Therefore, systematic monitoring of each team project work and schedule has resulted to one hour less in lecture time and one hour more in computer lab. Nowadays, the course involves a 3 hour practice in SAP R/3 and 2 hour lecture for 14 weeks.

Aiming at the better communication between teachers and the team project managers but also with the individual members of the project teams, an asynchronous tele-education environment named e-class is used. E-class is one of the tele-education platforms that are available at the Technical Education Institute of Larissa (<http://e-class.teilar.gr/>). E-class functionality that is used extensively includes defining user privileges, specifying groups of users, chatting (publicly or privately) with student teams, managing the agendas and dates of the meetings, announcements, exchanging e-mails and publishing ERP supporting material or students' deliverables. Most students are familiar with e-class system since they have already used it, in other modules of the department.

Project Evaluation

Each team project manager is asked to present to the CIOs, along with the intermediate/final deliverable, an intermediate/final team progress report. Progress reports help CIOs to evaluate projects at both the individual and the team level. Progress reports are actually composed of all "internal" project management documents, i.e., the project scope statement, the project plan (Gantt/PERT diagrams), the timesheet which chronicle the individual participation (in man hours) of each team member, the internal meeting minutes as well as the project risk management notes.

Students are given a high motivation to participate in project work. The grading of project work is equal to 70%, while class attendance is 5% and grade of the final exam is 25% of the final rank. It is stated explicitly that it is very important for students to

actively contribute in team work (which includes attending the team meetings, contributing their ideas, writing the deliverables etc.). In addition, familiarization with SAP R/3 and understanding of how SAP Business Workflow procedures represent business scenarios are considered significant for the final assessment.

Project evaluation is a continuous process for team project managers with the help of CIOs. A team project manager has to evaluate how well his/her project is progressing, how it can be improved, and whether project objectives are met. Periodic CIOs reviews involve evaluating the progress of each project, the completion of project activities, tasks and milestones, the project plan (in order to modify it as necessary), the success of the project outcomes etc. Nevertheless, evaluators of the final project deliverables (final project report, progress report and presentation) are not only the CIOs, since:

- at the end of the course, each team member individually may assess the contribution of other team members,
- Just after each final presentation, a pre-specified critique group of five students present their evaluation and suggestions on the presentation given by the presenting group and any additional recommendations they have on each project.

Finally, there are some reliable indications that the course processes help students to acquire ERP concepts, get more insight on how an enterprise information infrastructure works within a business environment and improve their technical ERP skills. For example:

- The average score of students' performance on the final exams is constantly increasing by 3.5% on every semester.
- Students are involved more actively in SAP R/3. During the latest course implementation (in year 2006), the 95% of projects were utilized SAP Business Workflow tools to describe their scenarios, while at the first course implementation (in year 2002), the corresponding number of projects was only the 37% of the total.

Course Evaluation and Conclusions

Course formative evaluation procedures take place on a continuous basis, since CIOs try to preserve a non-stop communication with team project managers as well as with all team members. Formative evaluation demonstrates some remedial measures during the course implementation (e.g., decrease lecture time and increase the length of SAP R/3 experimentation in the computer lab). Summative evaluation procedures take place at the conclusion of the course.

The same survey is disseminated to all students on every course implementation. The analysis of all answers gathered so far demonstrates some promising results:

- Students believe that the course is adequately organized (57%), course objectives are accomplished (58%) and the amount of the work that they performed is too much (82%).
- Student rate the course as moderately difficult (65%).
- A textbook in ERP systems is found of little help (69%), while supplementary Internet/ERP literature is absolutely necessary (85%).
- They believe that overall grading is reasonably fair (59%).
- They enjoy learning when working with the group (79%) and during practice with SAP R/3 (68%).
- Working with the group is identified (63%) among all course components the most beneficial to achieve the course requirements.
- They recognize (86%) that working productively with the team is their major acquired skill and believe that project working improved their PM skills (76%).
- They rank their competencies on using SAP R/3 as quite satisfactory (53%) and their understanding of business functions as sufficient enough (56%).
- They rate the course in terms of their technical development as extremely valuable (86%).
- They will possibly recommend this course to other students (42%).

As far as qualitative results are concerned, so far experience from introducing PBL in the ERP course of the curriculum of the PMD has revealed a number of assertions:

- Students participate more actively in the learning processes, a fact that is confirmed mainly by their classroom attendance. From the beginning of the semester students are involved in the project

work and realize early enough their team responsibilities.

- Students apply in practice project management methodologies, tools (e.g., MS Project, Primavera Planner) and techniques (PERT/CPM).
- They get a deeper and broader knowledge on technical ERP system issues and thus, they become more interested in ERP subjects. This claim is further justified as about 7.5% on the average of the graduate students in the subsequent final (8th) semester of the curriculum select ERP related subjects as the topic of their graduate dissertation.

The overall course assessment demonstrates the pedagogical value and effectiveness of the PBL model as a means of improving students' personal, collaborative and communication skills. Many students start to adopt a professional way of thinking. For example, they change some initial negative attitudes against collaborative work, since the majority of them were used to cooperate only with colleagues of their preference. Most of the students improve their communication skills. A subset of communication requirements is covered by the e-class asynchronous tele-education system. Statistics of e-class usage show a constant medium-level of system utilisation for the course purposes.

Assessment of different group composition levels is one of our current research efforts. In the current course implementation, group composition highly affects the performance and the quality of results of project work. For example, team project managers of high ability outperform teams with project managers of lower ability. Our strategic efforts will also be devoted to creating synergies across the other courses of the curriculum plan to produce benefits to students, faculty and the department as a whole.

Acknowledgment

The work presented in this article has been partially funded by the Greek Ministry of Education under the R&D project MISSION-SPM in the context of ARCHIMEDES II national programme.

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