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Abstract:

This study discusses project-based learning and describes a course that is designed around these principles. The study also examines the working-life requirements of today's IT project managers and assesses the potential of project-based learning in promoting the development of the necessary skills and knowledge for successful project management. The data were collected and combined from three different sources: Recent graduates (questionnaires, n=185) were asked to identify the most important skills they needed in their work; project managers (interviews, n=15) were asked their opinions of the contents and methods used when educating IT project managers; and students (interviews, n=58) were asked what they had learned during the project-based course. According to a comparative analysis of the three sets of data, the respondent groups were unanimous regarding two aspects of working-life requirements and learning outcomes: domain-specific knowledge and social skills. The graduates and the project managers saw these as vital in the work of IT professionals, and the students mentioned them as the most important learning outcomes. The findings suggest that project-based learning may provide students with a learning environment that prepares them well for their future working lives.

Keywords: project-based learning, project managers, project management, working-life skills

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I. INTRODUCTION

The project manager is a key person in accomplishing project success, and the most important factor in successful project management [Bloom 1996; Cleland 1984; 575; Kezsbom et al. 1989; 181; Nicholas 1994; 189; Verner et al. 1999]. He or she manages all the critical project functions, including planning, organizing, staffing, directing, and controlling [Thayer 1987]. According to Nicholas [1994 172], the role of the project manager is so important that "without it there would not even be project management—the project manager being the glue holding the project together and the mover and shaker spurring it on."

Yet there appears to be an increasing shortage of appropriately qualified project managers. Many managers responsible for information systems (IS) projects are either untrained or poorly trained for their work [Maqsood and Javed 2007]. The Software Productivity Research Company (USA) has indicated that less than 25 percent of U.S. software project managers received any formal training in software cost estimation, planning, or risk analysis [Jones 1999]. In a similar vein, Pinto and Kharbanda [1996] report an increased demand for qualified project managers [cf. Jurison 1999]. Thus, in practice it is hard to recruit an experienced project manager with the necessary broad experience and managerial skills.

What, then, are the knowledge and skills that successful project management in information technology (IT) sector[1] requires? A broad answer to this question is provided in three studies. The first was conducted by Lee et al. [1995], who reviewed the IS literature, conducted discussions in focus-group meetings, and interviewed IS managers. As a result they defined the following four broad categories of critical knowledge and skills required of IS professionals:

- *Technical Specialties Knowledge/Skills*: being up to date with rapidly changing technology;
- *Technology Management Knowledge/Skills*: where and how to deploy information technologies effectively and profitably;
- *Business Functional Knowledge/Skills*: the need to apply information technology to serve business goals and to reengineer business processes before the adoption of new IS;
- *Interpersonal and Management Knowledge/Skills*, or behavioral knowledge.

The second study was conducted by Abraham et al. [2006], who interviewed 104 senior IT managers with extensive knowledge of IT and IT workforce needs. From the results, they estimated that the skills that would be important by 2008 would be related to the business domain, sourcing, IT administration, project management, and technical know-how (IT architecture/standards and security). Critical entry-level capabilities include programming and other technical skills, but communication and industry knowledge were also cited as critical. The studies reviewed above show that the project manager is expected to manage complexity in projects. This view is supported by Xia and Lee [2004], who developed a taxonomy for the complexity of IS development projects (ISDPs), including technological, organizational, dynamic, and structural complexity. They argue that ISDP complexity and project performance are both multidimensional; hence the project manager must understand how the complexity of the ISDP affects project performance.

Given the role of the IT project manager, interestingly, many argue that technical skills are not as important as non-technical abilities in the areas of teamwork and communications, and self-awareness [Faraj and Sambamurthy 2006; Wateridge 1997; von Hellens et al. 2000; El-Sabaa 2001; Brewer 2005; Gillard 2005; Turner and Muller 2006]. These kinds of skills are often referred to as "soft skills" [e.g., Muzio, Fisher, Thomas, and Peters 2007 ; Sumner et al. 2006], "generic skills" [e.g., Canning 2007; Dunne, Bennett, and Carré 2000], or "transferable skills" [e.g., Fallows and Steven 2000]. The everyday assumption has been that they can be taught at school and transferred to other contexts. However, contrary to common belief, generic skills are highly context-dependent [Dunne et al. 2000] and, as Bereiter and Scardamalia [1993] state, they are very difficult to teach and their transferability to new situations must be questioned. Recent studies conducted among university graduates with some years of work experience have given support to these ideas. Such studies have shown that graduates often find their "generic skills" such as communication and social skills inadequate, and that the majority of them learn the most important skills at work

[1] For reasons of simplicity we use information technology (IT) as a general term to mean the whole computing field. As used in this study, the terms *IT sector*, *IT professional* and *IT project manager* should therefore be interpreted as general expressions. A precise division of the fields of computing is found in Computing Curricula 2005: Computing is divided into computer engineering (CE), computer science (CS), information systems (IS), information technology (IT), and software engineering (SE) disciplines.

[Tynjälä et al. 2006; Stenström 2006]; therefore, an important challenge for higher-education institutions is to develop pedagogical practices that allow students to participate in working life and to confront real-life problems as an integral part of their studies. Only in this way will it be possible to develop the kind of knowledge and competence that is needed in the world of work. We argue that this challenge cannot be met by confining university pedagogy to traditional methods such as lectures and text-book study, and we have to create new kinds of learning environments for students. Bereiter and Scardamalia [1993] argue as follows:

> If we want students to acquire the skills needed to function in knowledge-based, innovation-driven organizations, we should place them in an environment where those skills are required in order for them to be part of what is going on.

In the present paper we claim that, at least in terms of learning the skills required in a project manager's work, the above-mentioned challenge can be met if a project-based learning approach is adopted. Project-based learning takes different forms. In some courses the project work is carried out with a real-life client [Green 2003; Watson and Huber 2000; Cotterell and Hughes 1995; Brown et al. 1989], while in others the instructors create the assignments [Scott et al. 1994]. The focus in the present article is on work-related project learning carried out in collaboration with authentic clients.

In the following sections, we first outline our theoretical framework for project-based learning on the basis of recent research on learning. We then present a particular model of this pedagogical approach based on studies in the field of information systems design. The rest of the article describes our empirical research examining the extent to which project-based learning corresponds to the needs of working life in the IT sector, and in the work of project managers in particular.

II. A THEORETICAL FRAMEWORK FOR PROJECT-BASED LEARNING

Our theoretical starting point is the constructivist view of learning according to which learning occurs not as a result of passively receiving information, but as a result of the learner's active cognitive and social processing of knowledge [see e.g., von Glasersfeld 1984, 1995a,b; Duffy et al. 1993; Tynjälä 1999]. It is acknowledged that constructivism is not a unified theory; it rather subsumes many different positions such as radical or cognitive constructivism, social constructivism or the socio-cultural approach, symbolic interactionism, and social constructionism. What is common to these diverse views is the metaphorical description of learning as a building process in which knowledge is actively constructed by individuals and social communities in a process of negotiating meaning. [e.g., Duffy et al. 1993; Phillips 1995; Prawat,1996, 2000; Steffe 1995; Tynjälä 1999; von Glasersfeld 1984, 1995a, 2007; Geelan 2006].

The most important pedagogical implications of constructivism can be summarized as follows [cf. Tynjälä 1999]:

- The significance of learners' previous knowledge, beliefs, conceptions and misconceptions is emphasized and taken into account in the instructional design [Dochy 1992; Duit 1995; Vosniadou 1992a,b, 1994; Jonassen et al. 2005];
- Attention is paid to learners' meta-cognitive and self-regulative skills and knowledge [Boekaerts 2002; Boekaerts and Cascallar 2006; Brown 1987; Vermunt 1995, von Wright 1992];
- Negotiation and the sharing of meaning through discussion and different forms of collaboration are emphasized [Boekaerts and Minnaert 2006; Dillenbourg 1999; 2007; Gergen 1995];
- Multiple representations of concepts and information is utilized [Feltovich, Spiro and Coulson 1993; Lehtinen and Repo 1996; Lehtinen and Rui 1996; Spiro et al. 1995; van Someren et al. 1998];
- The situational nature of learning is taken into account and thus authentic or simulated environments are preferred, and knowledge acquisition and use are integrated [Eraut 2004; Helle et al. 2006; Lave and Wenger 1991; Mandl et al. 1996; Markovitz and Messerer 2006];
- Learning processes are characterized by problem-solving, the active processing of information (activated learning), and the production of concrete artifacts in the course of the learning process [e.g., Bereiter and Scardamalia 1993; Bereiter 2002; Bruner 1996; Jonassen and Hernandez-Serrano 2002; Lonka and Ahola 1995; Lonka 1997];
- The role of the teacher is to support and facilitate the learning process of students [e.g., Adams 2006; Prawat 2000; von Glasersfeld 2007];
- Assessment procedures are embedded in the learning processes, focus on authentic tasks, and take into account the learners' individual orientations and foster their meta-cognitive skills [Biggs 1996; Boud 1995; Dochy and Moerkerke 1997; Hansen 2004].

Recent models of project-based learning are very well in line with these pedagogical principles. The project-based method is a comprehensive approach to instruction. It is a learning model that involves students in problem-solving tasks and allows them to actively build and manage their own learning. The underlying principle is the assumption that learning occurs during unstructured and complex activities [Helle et al. 2006]. Project-based learning itself does not always require authentic work tasks [Blumenfeld et al. 1991]; however, at university level, real-world work assignments are often utilized in order to achieve mandated performance objectives, and to facilitate individual and collective learning [Smith and Dods 1997]. The present study reports on the application of the constructivist design principles described above in a project-based learning course in information systems, as shown in Table 1.

Table 1. The Implementation of Constructivist Design Principles in Project-Based Learning

Characteristics of constructivist learning environments	**Application in the project based course**
Taking into account students' previous knowledge and conceptions	At the beginning of the course: reflection on previous experiences and conceptions of project work through writing and discussion
Paying attention to students' meta-cognitive and self-regulative skills	Having students reflect on their own learning in learning journals and weekly discussions with the university teacher Having students plan a system for the monitoring of their time management
Negotiation and the sharing of meanings through discussion and collaborative learning	Carrying out projects in groups. Supporting collaboration through mentoring. Regarding the group as the basic unit of working and learning
Problem solving and the construction of artifacts	Project work itself as joint problem solving involving planning and developing a concrete artifact
Situated learning; an authentic or simulated learning environment	Commissioned project assignments from authentic clients
The teacher as a facilitator of learning	Regular discussions with the university teacher and the workplace mentor
Process-driven assessment fostering meta-cognitive skills	Student self-assessment focusing on the learning process + assessment by the teacher and the workplace mentor

Helle et al. [2006a] describe five significant features of project-based learning that distinguish it from other forms of learning. First, there is the idea that a problem or question serves to drive learning activities. Second, the construction of a concrete artifact distinguishes project-based learning from problem-based learning (PBL), in which students usually work on paper cases without any concrete end product. Third, learner control of the learning process leaves scope for decisions regarding pacing, sequencing and actual content. The strength of this is that it motivates and gives students the possibility to work toward a solution in their own idiosyncratic ways. Fourth, the contextualization of learning is evident in project-based courses, since a project commissioned by a business organization will provide students with an authentic learning environment. Fifth, the project method allows the use and creation of multiple forms of representation, that is, the combined use of knowledge in different forms (abstract, concrete, verbal and visual, for example). Finally, Helle et al. [2006] note that projects are complex enough to induce students to generate questions of their own. In the course of designing problems and generating questions they are likely to develop a sense of ownership of the learning process. This, in turn, results in increased motivation [see Helle et al. 2007].

Developing generic skills such as teamwork is an integral element in many models of project-based learning: teamwork is an inherent part of the project. Students involved in projects practice a vast range of skills in areas of project management, teamwork, and communications technology—and also in self assessment. Often collaborative skills are put into action by the collaborative nature of project management. In fact, recent studies have suggested that project work may have many educational and social benefits [Moses et al. 2000], such as the development of communication skills [Pigford 1992; Fritz 1987], along with team-building and interpersonal skills [Roberts 2000; Ross and Ruhleder 1993].

Project work in the computing fields gives students the possibility to prepare for professional practice by applying "programming-in-the-large" and by producing plans, managing schedules, interviewing users and meeting project deadlines [e.g., Oliver and Dalbey 1994; Sumner 1987]. Moreover, project work makes it possible for students to apply theoretical knowledge to practice [Rebelsky and Flynt 2000; Byrkett 1987], which is important for the development of expertise [Bereiter and Scardamalia 1993; Leinhardt et al. 1995; Tynjälä et al. 2003; Tynjälä 2008a, 2008b]. In terms of expertise, it is also worth mentioning that project studies may enable students to participate in the creation of new knowledge rather than confining themselves to the acquisition of existing knowledge. According to Hakkarainen et al. [2004], the knowledge-creation perspective is the most dynamic aspect of expertise, from both the individual and the societal perspective. For this reason it is important to support knowledge-creation activities during university studies [see also Helle et al. 2006].

In the next section we shall describe the particular model of project-based learning under investigation.

A Description of the Project-Based Learning Model and the Course

Naturally there are different ways of organizing project-based learning and work-related project learning. In our study we focus on a particular model, developed at the Department of Computer Science and Information Systems at the University of Jyväskylä, Finland. The course in question is called the Development Project Course, and it is usually taken in the third year of studies.

The Model and the Learning Objectives

The main aim of the Development Project Course is to give the students the opportunity to gain authentic practical experience of information systems projects. The learning objective is to provide the learners with a comprehensive and realistic view of the work of information systems experts in both project management and implementation. Further objectives include familiarizing the students with the tools and methods of the project domain, ensuring that they acquire communication skills and teamwork competence, as well as project-management and planning skills. They work in close co-operation with the client in weekly meetings. During the collaboration the students are supervised both by client representatives and by university teachers. The basic idea or emphasis is that very specific technical guidance should come from the client whenever possible, whereas the university is responsible for more generic guidance (e.g., planning and reporting). In addition, guest lecturers from client organizations give lectures on topics of relevance to project management. The learning environment fosters project-based learning, the aim of which is to support students in attaining their learning objectives, which in this case include the acquisition of project-management skills, leadership and group-work skills, communication skills, and technical competence (see Table 2 for a more specific description of what constitutes these skills are and how they are acquired).

Table 2. The Objectives and Realization of the Project Course [adapted from Pirhonen and Hämäläinen 2005, p. 35]

Learning objective	What?	How?
Project-management skills	Project planning, risk management, scope management, follow-through of the project	Project plan, risk plan, phase plans and reports, weekly plans and reports, inspection meetings, steering-group meetings, acting as a project manager, lectures given by experts, theme seminars
Leadership and group-work skills	Goal-oriented and responsible action, recognizing the stages of group development, team spirit, team members' roles	Allocating the tasks equitable to the team for attaining project objectives, weekly meetings with the supervisor, team meetings, discussions, peer reviews
Communication skills	Negotiation techniques, meeting practices, skills in public performance, spoken and written communication	Communication plan, team meetings, meetings with the client, supervisors, and project managers; steering-group meetings, seminars, presentations, agendas, memos, minutes, e-mail
Technical competence	Knowledge of the project substance	Acquainting oneself with the project scope, identifying the training needs for carrying out an assignment, schooling oneself, planned use of the resources of the client and the support group

The Learning Environment and The Project Tasks

The learning environment is maintained in co-ordination with three parties—the student group, the university, and the client organization (Figure 1). A written cooperation contract between the three parties is drawn up before the project starts. It covers the subject matter (a description of the project objectives), the obligations and rights of the contracting parties, copyrights, guarantees and maintenance, confidentiality and the concealment of confidential information, payments and the payment schedule.

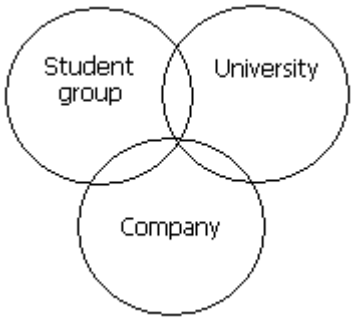

Figure 1. The Actors in the Learning Environment

The client typically represents a firm such as a software house or the IT department of an industrial organization. The tasks range from extreme coding projects to developmental projects and research. They are typically ill-defined and need to be clarified as the project proceeds. Four examples of project tasks follow. The texts have been translated from Finnish into English from the course website, where the students produce their project homepages [Vartiainen 2005]:

1. The task of the [name of a project group] group is to investigate the usage of EJB (Enterprise Java Beans) in n-layered environment. The goal is to examine the potential uses of EJB in delivering information between the client and the server components. In addition to this, the project group will program a small prototype.

2. The task of the [name of a project group] group is to investigate product management and different sectors of software engineering in [name of a client], and to analyze and describe the salient concepts and processes relating to them. In addition to this, the group will produce a report based on the concepts, methods, tools, and best practices found in the market, and which assesses the functionality of new operational models in managing infrastructure products in the workstation environment in [name of the client].

3. The purpose of the project is to implement an information-transportation protocol for [name of system], a client-server system developed by [name of a client] for reading and managing information about energy.

4. The task of the project is to map the security level of [name of a client] and to produce real recommendations and solution models for improving these security levels.

The Project Organization

The project organization comprises a group of between four and five students, supervisors, and client representatives (see Figure 2). The steering group is selected during the initial stage and consists of representatives of the client organization, the university (supervisors) and the project team (the project manager and secretary in turn). It represents the highest authority in terms of decision-making, and decides on matters concerning the plans and issues related to the redefinition of the project content. One of the client representatives chairs the group meetings and the project-team manager presents the state of the project. Experts or consultants may also be invited to the steering-group meetings.

Each project group has two supervisors from the university, one of whom is the vice-supervisor. These people are the facilitators and/or coaches who promote the collaboration and provide support and guidance. The supervisor also has an important role in promoting students' reflection on their work. Especially in the early stages of the project, the role of the supervisor is vital in supporting communication and cooperation with the client. The experiences of supervisors have shown that the start-up phase needs to be conducted in a systematic way if it is to contribute to project success. Supervisors guide processes of groups: a supervisor and a group meet in weekly

guidance meeting. The main objective of the meetings is to critically reflect on one's own way of working and learning. During these meetings, the weekly reports and plans are discussed. The project manager and team members report on the state of the project and compare the state of the project to the expectations in the project plan. Issues that can cause problems in carrying out the project are discussed as well. For the development of students' reflective evaluation, the groups are asked to formulate plans, track progress, construct and test alternative solutions and evaluate their hypothetical consequences. In addition, they weekly write up a learning diary that contains their reflection on their working and learning. The supervisors' duty is to create questioning culture among the group and to direct them to use actively instruction and expert recourses available. Supervisors only have responsibility for the fulfillment of the academic learning objectives, not for project results to the client. They guide the students in finding the essential aspects for carrying out the task. Decision-making is left to the group, although the supervisor can provide a timeline for the process. The support group includes the network set up by the client, which provides the project group with content-related professional help when needed.

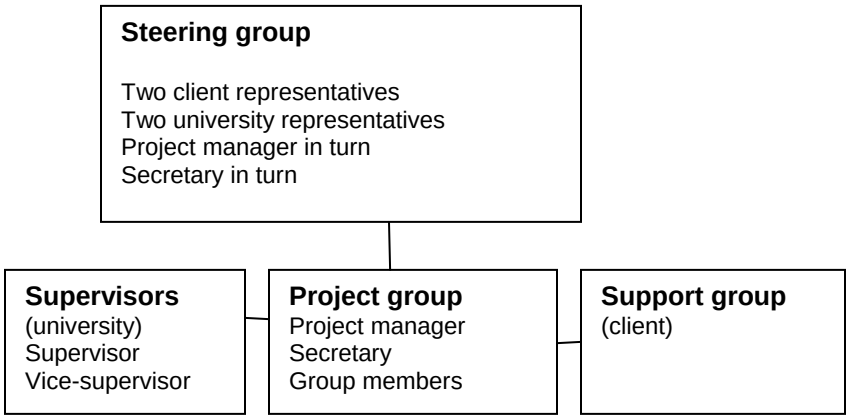

Figure 2. Project Organization

Duration

The project course lasts from the beginning of September to the end of March (26 weeks). The course starts with lectures and orientation exercises for the students. The students form their own groups of four to five members before the task-exhibition session at which the client representatives present the project assignments. After this session the student groups negotiate the distribution of the project tasks. During the course each student is expected to use 275 hours for implementing the project task and 125 hours for demonstrating project-work skills, including project leading, group work, and communication. The groups plan their work, complete the scheduled tasks, and produce deliverables. Each student is expected to take the role of project manager and project secretary. These roles rotate every month so that each member of the project team works in both roles once. In total, a five-student group uses 1,375 hours in planning and implementing the client project. The collaboration ends with a steering group meeting at which the results of the student project are accepted.

The Assessment

The aim of the assessment process is to recognize what the students learn during the project course. There are two assessment points, the first in mid-December after three months' work, and the final one at the end of the project in April. In terms of content, the assessment is grouped and structured around themes covering issues related to the process (group work, planning, and communication and co-operation), student attitude and the project outcome. The following coefficients are used for the assessment categories: process 70 percent (group work 25 percent, planning 25 percent, and communication and co-operation 20 percent), attitude 10 percent, and outcome 20 percent. The group process is assessed and each student is given an individual grade.

As part of the assessment process both the teams and the supervisor write a report in line with the given framework. The assessment is based on perceptions of teamwork and documentation of the project process (e.g., plans, reports, memos, and minutes). The project outcomes are assessed only by the client. Following the delivery of the written assessments, the supervisors and the team discuss them in order to establish the causes of success and failure. The course grades are determined based mainly on the debates that emerge in the discussion on the written assessment. Both supervisors and students have the right to suggest an individual student mark that is different from the collective mark given to the group. These personal marks are based on unanimous decisions.

The focus in the present study is on the project-based learning model described above, which is examined from the perspective of working-life requirements. For this purpose we collected data on these requirements from different sources, which we compared with the data gathered from the project-based course. In the following sections we present the more detailed research questions and describe the methodology of the study.

III. THE AIM OF THE STUDY AND THE RESEARCH PROBLEMS

The purpose of the study was to examine the extent to which project-based learning at university corresponds to the needs of working life. More specifically, we aimed to answer the following research questions:

1. What kind of competences do project managers working in the field of information and communications technology need?
2. What kind of learning outcomes do project-based studies at university produce?
3. How do the self-reported learning outcomes of the project-based studies correspond to the identified needs of working life?

IV. METHOD

In addressing our research questions we needed to utilize, combine and re-analyze data from three different sources. For the first one regarding the competences needed in the work of a project manager we administered a questionnaire to information systems graduates with between two and 10 years of work experience, and conducted interviews with experienced project managers, and for the second concerning the self-reported outcomes of project-based learning we interviewed students who had just completed the Development Project Course described above. Finally, in order to answer our third question we combined and compared the data collected from various sources. In the following we describe each method in more detail.

Questionnaire To Information Systems Graduates

The questionnaire study was part of a larger research project [Tynjälä et al. 2006] examining how university graduates perceive the qualifications and competences needed in their profession and how they see the role of university education in providing those skills. The target group consisted of 2,712 alumni from three Finnish universities with degrees in one of four areas: information systems, teacher education, general educational sciences and pharmacy. The response rate was 35 percent (n=955), which is typical for postal surveys: it was slightly lower for computer-science graduates, 27 percent (n=185). The questions concerned the graduates' work history, current job, work tasks, the skills they needed and their experiences of their university education. In the present study we focus on working-life competences. The respondents were asked an open-ended question:

What are the most important skills or qualities you need in your job?

The answers were classified into five categories [adapted from Väärälä 1995]: 1) domain-specific production and technical competences, which included domain-specific professional skills and knowledge; 2) motivational characteristics, which refer to personal qualities such as commitment, motivation, goal setting and aspiration; 3) adaptive characteristics, including adaptation to work requirements and pressures; 4) social skills such as communication skills, team-work skills, negotiation skills, representation skills and general people skills; and 5) innovative abilities, which refer to the skills needed in the development of work tasks and products and include creativity, innovativeness, problem-solving skills, developmental orientation and learning skills. The classification was carried out by a trained research assistant.

Interviews with Experienced Project Managers

Project managers with considerable working experience (five to 10 years) in software projects were interviewed during the years 2005 and 2006. The companies they worked for mostly represented large enterprises located in the regions around Tampere, Turku, Pori and Jyväskylä, in Finland. The interviews were carried out in two phases. First, the third author conducted a group-discussion exercise with five IT project managers in a large manufacturing company (in 2005). He presented the interview task at the start and asked prompting questions in order to move the discussion along. Second, 10 IT project managers from software houses were interviewed and asked the same question (in spring 2006): the second and third authors each interviewed five subjects. The age and gender profiles of the project managers, coded PM1…PM15, were (na = not available; F=female, M=male): na/M, na/M, na/F, na/M, na/F, 41/M, 42/M, 42/F, 59/M, 46/F, 50/M, 38/M, 35/M, 43/M, and 41/M. In order to obtain rich descriptions the authors formulated an open-ended interview question (the IT abbreviation was chosen as it is commonly used in Finland to refer to the computing field as whole):

Universities educate future IT project managers. What themes should be considered in the education and how should they be taught? (Recall your own education. What would you have wanted to learn?)

The second and third authors recorded and transcribed all the discussions and interviews. Interpretive content analysis as developed by Lacity and Janson [1994, p. 148] was then applied to the interview data. This approach takes into account the contextual circumstances in which the respondents frame their answers and the circumstances that influence the researchers' interpretations. The analysis proceeded as follows: the third author produced a preliminary classification of the issues that emerged from the interviews, which the second author then reviewed. After a few iterations they agreed on the final classification presented in the Results section.

Interviews with students

The first and the fourth authors interviewed 48 (83 percent) of the 58 students taking the Development Project course. Neither of the interviewers were instructors of the course. The semi-structured interviews covered the following themes: the students' learning orientations and subjective learning outcomes, the development of expertise, group processes, and the use of IT tools. In the present study we focus on experienced learning outcomes, in other words on what the students felt they had learned during the project-based course. A simple question was asked:

What did you learn during the project course?

The recorded and transcribed answers were analyzed in two phases: first, the fourth author coded the responses using a coding scheme derived from the data [see Helle et al. 2007], and secondly, the first and fourth authors reduced the categories to three basic groups.

Combining the data

In the last phase of our study we combined the data described above and made a comparative analysis. For this we compiled the main results of each sub-study in a table and examined the relationships between the views about the requirements of IT project managers (expressed by the project managers and information systems graduates) and the self-reported learning outcomes of project-based studies (expressed by the information systems students who had completed the project-based course).

V. RESULTS

The Information Systems Graduates' Views of the Skills Needed in their Jobs

Figure 3 shows the distribution of the respondents' answers to the question concerning the most important skills they needed in their current jobs. More than one third of the graduates from IS study program thought that innovative skills such as creativity, problem-solving skills, learning skills and developmental orientation were most often required, followed by domain-specific production and technical and social skills (mentioned by 26-27 percent). Motivational and adaptation skills were less often considered the most important. All in all, the findings suggest that in addition to managing domain-specific knowledge, IS professionals must have different kinds of innovative and social skills.

The Project Managers' Perceptions of the Content and Method of Teaching

The project managers' perceptions of what should be taught to future project managers fell into three broad categories: real-life experience of a diversity of projects, management, and interpersonal competence. It became evident that the project managers thought that the skills should be acquired through practical experience. The categories were as follows:

Real Experience of a Diversity of Projects

Students should understand how entire projects are managed in real life, and get a general picture of IT projects (e.g., diversity in terms of types of projects and clients, business, technical issues, and architecture). The interviewed project managers suspected that students would not acquire this kind of understanding in educational institutes. Project courses with real-life clients were mentioned as possible means for meeting these needs. The following three extracts exemplify these concerns:

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PM1: “Generally, more problems emerge if you are a far too in-depth specialist at the beginning of your career. OK, you might find a very good job that matches it [your specialty] but the probability is quite small. I think it’s more important that you have a solid general picture of things…”

PM6: “Preparing for the brutal reality because there is this gap between education and working life. … There should be something concrete [in the education]. There should be problems from real life. Management by situation is a good example. Is a person strong and competent and so forth? How do you lead people in such situations?”

PM9: “They [students] should lead a project there [at the university]. Perhaps they do, I don’t know. The kind of projects that involve outside parties, clients. After learning the theory they should implement a project that satisfies the client.”

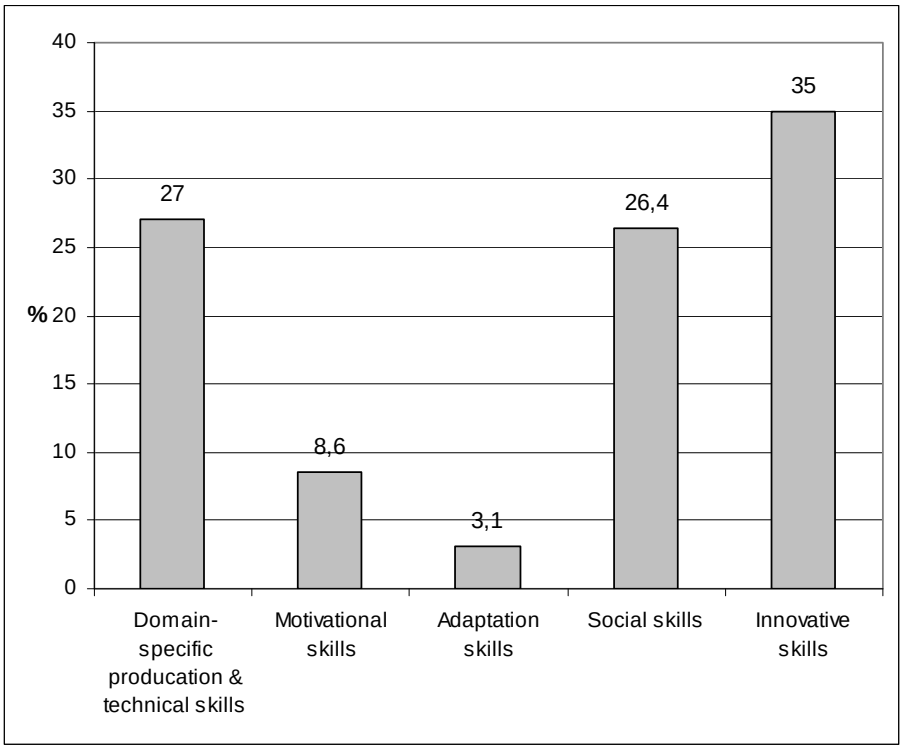

Figure 3. The Skills Needed most in IS Jobs according to IS Graduates with between Two and 10 Years of Work Experience (n=185)

Management Skills

The following management skills emerged in the project managers’ perceptions:

- Planning the whole project
- Managing the project process and the critical work tasks (e.g., follow-up inspections)
- Making project offers
- Cost management
- Managing contracts
- Familiarity with the law

Two extracts follow. The first one refers to “making a project offer” and the second to “economics issues” as critical in the work of a project manager:

PM5: “When a new project manager joins our firm, I invite him or her to formulate a project offer with me and we devise four to five versions of it together. This is how they learn the basics. Then there are the legal issues so that you don’t mess up with your project.”

PM4: “Project economics are important in addition to the technical issues: money is the most significant bone of contention with the client”.

Interpersonal Competences

In addition to the management skills that are targeted directly on attaining the results there is significant need to consider interpersonal competences. Many project managers expressed the concern that education does not deal with human aspects properly. Therefore they raised the following themes:

- Team work, team building
- Psychological issues (e.g., personality types)
- Communication skills
- The development of self-knowledge

The following example refers to the lack of concern for human issues in education:

> PM8: "Many kinds of project-management software and courses exist but how to deal with people is not considered. After all, project success or failure depends on it and on how people feel after the project… For example, technical issues may differ but people always exist. This viewpoint has to be taken into account."

Communications skills were considered critical. Everything in a project was perceived to depend on how the project manager is able to communicate with the stakeholders. These skills were discussed in the group discussion among five project managers:

> PM10: "There's something I have noticed. In a way it's a small issue but in practice it's very significant. Abilities as a public performer and presentation skills. How you present things is very important."
> PM11: "And communication skills."
> PM10: "Well, communication in general."
> PM11: "That you are able to take the audience into account and how you get your ideas through."

Students should develop self-knowledge of their capabilities. This would help them to make the right choice between a prospective future career as a project manager or a technical specialist, according to the project managers' perceptions. The following extract exemplifies these concerns:

> PM2: "From the beginning everyone should ask themselves if they want to be a gasbag who uses their time for caring and herding and keeping up communications and interaction and keeping people satisfied. You would be a kind of, how could I put it, a nurturer or a coach. Or do you want to be the center-forward who implements the technical work tasks. These are two completely different things and that's why everyone should ask themselves what they want to be".

Experienced Learning Outcomes in the Project-Based Course

The following categories of learning outcomes were formed on the basis of the data-driven qualitative analysis of the student interviews: 1) Domain-specific skills and knowledge; 2) A stronger professional self-concept and clear career prospects; 3) Client-related learning; 4) Communication with different people; and 5) Holistic managerial competence, including project management and an integrative view of building an information system [Helle et al. 2007]. In the following section, we shall describe these categories in more detail, and also give numerical data on how often these perceptions were mentioned by the students; however, it is important to keep in mind that the categories were formed on the basis of answers to open interview questions. It is a well-known fact that the frequencies of answers to identical questions can vary according to the data collection method. Open-ended questions yield much lower frequencies than ready-made statements. Because of this, the percentages or frequencies reported below should not be taken as statistical facts, but rather as an approximate indication of how common these perceptions were as spontaneous reactions. The purpose of the qualitative analysis was not to produce numerical information but to get a general outline of self-perceived learning outcomes—that is, a general idea of the kinds of outcomes that are possible.

Domain-Specific Skills

The vast majority of students, that is more than 80 percent, reported having applied and acquired domain-specific knowledge and skills during the Development Project course. They often specifically mentioned established ways of modeling or flowcharting (i.e. ways of describing a system), and programming. The majority also said that they had learned how to use new tools, and some mentioned learning a new programming language.

A Stronger Professional Self-Concept and Clear Career Prospects

Again, majority of students (more than 60 percent) felt that the project-based course had had a beneficial effect on their professional self-concept and had strengthened their identity as a (future) IT professional. This was often

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experienced as increased self-confidence, as in the following citation: (ST8) “A massive increase in self-confidence in terms of one’s competence. You saw that you could do something for real.”

Client-Related Learning

Learning outcomes related to dealing with clients were often concerned with people skills. For example, 20 students out of 48 reported having learned how to get along with different clients, how to react when the client proposes sudden changes in plans, and how to clear up misunderstandings. Some also mentioned that they had learned to see things from the clients’ point of view.

Communication with Different People

This category of learning outcomes resembled the previous one but included answers that explicitly referred to developing communication skills. For example, 16 students spontaneously mentioned that they had acquired skills in negotiating, collaborating, and giving presentations in the steering-group meetings. They also felt that they had learned how to communicate in a systematic way, and had gained insights into intra-group and external communication. Those who had dealt with foreign clients reported that they had learned more about the English language during the project, and some also mentioned learning how to communicate with non-professionals.

Holistic Managerial Competence

Learning about project management was one of the main goals of the Development Project course, and according to the student interviews this goal was very well achieved. Approximately a half of the students spontaneously mentioned project-management skills when asked about learning outcomes. They often described their learning in terms of systematic working procedures or resource management. However, there were differences between the project groups in how they approached resource management: some teams put considerable effort into trying different types of systems and seemed to gain experience of what works and what does not; by contrast, others reported that they did not much pay attention to resource or management techniques or tools.

Some students explicitly described their new insights into the project manager’s role, for example: (STU53): “Well, at the beginning of the project [the project manager] naturally has to delegate tasks and arrange things and this perhaps requires a more commanding or dictatorial approach, whereas in the design phase it’s important that the whole group participates and the project manager probably does not have such a dominating position that he would tell someone now you do this and that. Instead people have to decide together what to do.”

Acquiring holistic managerial competence may also involve taking an integrative view of building an information system. This integrative learning was often articulated in terms of “project phases” or applying certain models of information systems design. In the following example a student makes an articulate connection with the design cycle: (STU4): “Well, right from the beginning and in our project plan we adopted the spiral model, in other words the systems-development model, which is based on iterations. We discarded the waterfall model right at the beginning, because it would not have been suitable for prototype development.”

In the second phase of the analysis we further condensed the learning-outcome categories described above into three main groups: 1) domain-specific knowledge, 2) generic working-life competences, and 3) professional identity.

How do the outcomes of project-based studies correspond to the needs of working life?

Table 3 sets out the main findings of the analyses of the three independent sets of data.

A comparison of the views expressed by the IS graduates, project managers and students of information systems reveals both similarities and differences. There is total overlap and unanimity with regard to two aspects of working-life requirements and learning outcomes: 1) domain-specific knowledge and 2) social skills. The latter are expressed in a variety of ways but the message is the same: communication skills, the ability to engage in team working, and negotiation skills are essential in IT project management.

As for domain-specific knowledge, there are some differences in emphasis. While the project managers spoke about knowledge of different types of projects, grasping the general picture and understanding the project process, the students naturally referred to the project experience provided in the course, and mentioned project management and taking an integrative view of IS design as examples of knowledge and skills specific to information system project expertise. What the project managers brought up and the students did not was the perspective of economics and the law, which was probably due to the fact that economics and law are not taught in the DP course.

The third strong overlap between the different views concerns the development of the IT professionals’ professional identity or self-knowledge. The project managers emphasized the importance of deliberation on the choice of a

prospective career as either a project manager or a technical specialist. Similarly, the students who had taken the project-based course often mentioned that the course had helped them to clarify their future career prospects.

A striking difference between the views of the three groups was that while the IS graduates considered innovative skills very important in their current jobs, neither the interviewed project managers nor the IS students paid attention to innovative learning or knowledge creation. References to motivational and adaptive skills or characteristics similarly appeared in the data from the IS graduates (although to a lesser extent), but did not feature at all among the project managers and project students.

Table 3. Correspondence between the Needs of Working Life (expressed by IS graduates and project managers) and the Outcomes of Project-Based Learning (expressed by students on the project-based course)

IS graduates: the most important skills needed at work [Tynjälä et al. 2006]	Project managers: the content and method of teaching future project managers	Students on the project-based course: experienced learning outcomes [Helle et al. 2007]
Innovative skills (e.g., creativity, innovativeness, developmental orientation, learning skills, problem-solving skills)		
Domain-specific knowledge and skills	Diversity of project types and clients Project-management skills: planning the whole project, critical work tasks in projects, economics, and the law	Domain-specific skills and knowledge Holistic managerial competence (incl. project management + an integrative view of IS design)
Social skills (e.g., communication skills, team-work skills, negotiation skills, representation skills, people skills)	Inter-personal competences: team work, team building Psychological issues Communication skills	Client-related learning Communication with different people
(Minor emphasis): Motivational characteristics (e.g., commitment, motivation, goal setting, aspiration)		
(Minor emphasis): adaptive characteristics (e.g., adaptation to work pressures)		
	Self-knowledge	Professional identity: the strengthening of the professional self-concept and the clarification of career prospects

In summary, our comparative analysis indicates a strong overlap between the competence needs identified in working life and the self-reported learning outcomes of students on the project-based course. In particular, this is evident in domain-specific skills and knowledge related to project management, and in generic working-life skills, especially with regard to communication and interacting with other people.

VI. DISCUSSION

In our study, we considered the potential of project-based learning for meeting the challenge of educating IT professionals who are well prepared to act as project managers. We first collected data about working-life requirements from two groups we thought could best give us an insight into the work of IT professionals and project managers: 1) information systems graduates with several years of work experience and 2) IT project managers with several years of experience. In the second phase of the study we compared these groups' views with the learning outcomes of the students who had just completed a project-based course in information systems design. The students reported that during the course they had acquired domain-specific knowledge, project-management skills, and generic working-life skills in areas such as communication and teamwork. These are exactly the same skills that the project managers suggested were the most important things to be taught to students. Similarly, the IS graduates emphasized the importance of these skills and knowledge. These findings are in accordance with a recommendation put forward by Abraham et al. [2006]: IS programs should provide business-context-driven education to enable

students to acquire business and client-facing skills. We can thus conclude that the project-based course achieved its aims and could be seen as a working solution in the education of IT professionals.

Despite the general correspondence between the learning outcomes of the project-based course and the views of the professionals, there was also one striking difference: although the information systems graduates considered innovative skills essential in their work, neither the project managers nor the students mentioned innovativeness as a learning outcome or as something that should be taught to students. This discrepancy may be attributable to the different question formats used and the contexts of the three respondent groups. The information systems graduates were asked about the competences they needed in their work, while the project managers were asked what and how students should be taught at the university. It is possible that the innovation perspective is something that does not easily come to mind in the context of teaching. Similarly, it may be that it is not recognizable as a learning outcome in a course lasting a few months. The different types of data analysis may also have had an effect: the information systems graduates' data was coded on the basis of a theory-driven, ready-made classification, while the other two sets were coded according to data-driven methodology. It should also be noted that the analyses of the three data sets were conducted by different researchers independently of each other. In addition, the fact that not all information systems graduates work as project managers may have influenced the responses.

There may be some methodological limitations in our study. We used different methods in collecting the data from three groups (questionnaires for one group and interviews for the other two). Consequently, the sample sizes differed a lot. It is not possible in interview studies to collect data from a very big group, which may result in a biased sample. However, we think that the sample size of 15 in the project managers' data is enough to bring out the variation in work experience and in views of what the students should be taught. Another potential limitation is that the questions presented to the three groups were different: the information systems graduates were asked about the skills they needed at work, the project managers were asked to give their opinions on the contents and methods used in the education of IT professionals, and the students were asked about their learning outcomes in the project-based course. Different question formats undoubtedly produce different types of answers, which may or may be not comparable. The different question format was a necessity, however, because of the different positions and contexts of the three target groups. In addition, interviewing as a data-gathering method is problematic [see Fielding 1993 for details]. For example, the interviewee may understand the question in a way that was not intended by the interviewer. The fact that different researchers analyzed the three data sets has both pros and cons. One of the benefits is that the results were produced independently of each other, which makes any comparison more reliable. However, if the same researchers had carried out the analyses it would have resulted in more similar classifications because they probably would have used exactly the same terminology to describe similar categories. We produced categories that looked alike (in the different data sets) but were given different, albeit similar names. The classifications produced from our interview data make it possible to construct more detailed questionnaire items, which means that bigger samples of each target group can be used in future research.

As for the notion of *work-based* project learning itself, the study suggests that using authentic project commissions brings additional value to learning outcomes as compared to "canned" projects, or project exercises carried out in university settings. In our study, the students reported learning outcomes such as client-related learning, communicating with different people and strengthening professional identity—aspects that are probably less likely to emerge in classroom settings. In studies on traditional classroom instruction, students have reported learning outcomes that relate to the acquisition of theoretical knowledge, coupled with an almost total lack of experiences of learning more generic skills [e.g., Tynjälä 1999].

An obvious problem in organizing work-based projects is the fact that it takes a lot of resources, especially time and work, on the part of the instructors as well as the students. However, we see a trade-off in the potential of authentic experience to enhance both student motivation and learning outcomes, as compared to classroom study [see Helle et al. 2007b]. Our investigation was carried out in a European work and education context, which may raise questions about the generalizability of the findings to other regions, such as the American or Asian continents. We would take the view that in today's globalised world the requirements and skill structures of IT project managers are fairly similar all over the world. Nevertheless, in order to get comparable data we would welcome replicative studies in other regions.

VII. CONCLUSIONS

On the basis of our findings, we can conclude that project-based learning provides students with a learning environment that prepares them well for their future work. The students indicated that, in general, they were acquiring the skills and knowledge that IT professionals considered the most important in their work. These include both domain-specific knowledge (in this case about project management in particular, but also other forms of domain knowledge) and more generic working-life skills such as the ability to communicate and engage in teamwork. A

further important finding was that project-based learning appears to contribute to strengthening students' professional identity.

REFERENCES

Abraham, T., C. Beath, C. Bullen, K. Gallagher, T. Goles, K. Kaiser, and J. Simon. (2006). "IT Workforce Trends: Implications for IS Programs," *Communications of the Association for Information Systems* (17), pp. 1147-1170.

Adams, P. (2006). "Demystifying Constructivism: The Role of Teacher in New Technology Exploiting Learning Situations," in Tan, L., W. Hin, and R. Subramaniam (eds.) *Handbook of Research on Literacy in Technology at the K-12 Level*, pp. 493-514. Hershey, PA: Idea Group Reference/IGI Global.

Bereiter, C. (2002). *Education and Mind in the Knowledge Age*. Mahwah, NJ: Erlbaum.

Bereiter, C. and M. Scardamalia. (1993). *Surpassing Ourselves: An Inquiry into the Nature of Expertise*. Chicago: Open Court.

Biggs, J. (1996). "Enhancing Teaching through Constructive Alignment," *Higher Education* 32, 347-364.

Bloom, N. L. (1996). "Select the Right IS Project Manager for Success." *Personnel Journal* (75)1, pp. 6-9.

Blumenfeld, P. C., E. Soloway, R. W. Marx, J. S. Krajcik, M. Guzdial, and A. Palincsar. (1991). "Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning," *Educational Psychologist* (26)3and4, pp. 369-398.

Boekaerts, M. (2002). "Bringing about Change in the Classroom: Strengths and Weaknesses of the Self-Regulated Learning Approaches," *Learning and Instruction* 12(6), 589-604.

Boekaerts, M. and E. Cascallar. (2006). "How Far Have We Moved toward the Integration of Theory and Practice in Self-Regulation?" *Educational Psychology Review* 18(3), 199-210.

Boekaerts, M and A. Minnaert. (2006). "Affective and Motivational Outcomes of Working in Collaborative Groups," *Educational Psychology* 26(2), 187-208.

Boud, D. (1995). "Assessment and Learning: Contradictory or Complementary?" in P. Knight (Ed.) *Assessment for Learning in Higher Education* (pp. 35-48). London: Kogan Page.

Brewer, J. L. (2005). "Project Managers: Can We Make Them or Just Make Them Better?" *SIGITE '05: Proceedings of the Sixth Conference on Information Technology Education*, pp. 167-173.

Brown, A. (1987). "Metacognition, Executive Control, Self-Regulation, and Other More Mysterious Mechanisms," In F. Weinert and R. Kluwe (Eds.), *Metacognition, Motivation and Understanding*. Hillsdale, NJ: Erlbaum.

Brown, C. M., E. M. Sheppard, J. F. Vetelino, and M. Galin. (1989). "University-Industry Technology Interchange through a Unique Engineering Projects Course," *IEEE Transactions on Education* 32 (3), 343-348.

Bruner, J. (1996). *The Culture of Education*. Cambridge, MA: Harward University Press.

Byrkett, D. L. (1987). "Implementing Student Projects in a Simulation Course," In A. Thesen, H. Grant, D. Kelton (Eds.) Proceedings of the 1987 Winter Simulation Conference. New York: ACM Press. 77-81.

Canning, R. (2007). "Reconceptualising Core Skills," *Journal of Education and Work* 20 (1), 17-26.

Cleland, D. (1984). *Matrix Management Systems Handbook*, New York: Van Nostrand Reinhold.

Computing Curricula. (2005). "The Overview Report" covering undergraduate degree programs in Computer Engineering, Computer Science, Information Systems, Information Technology, Software Engineering. http://www.acm.org/education/education/curric_vols/CC2005-March06Final.pdf (current Oct. 7, 2008).

Cotterell, M. and B. Hughes. (1995). *Software Project Management*. London: International Thomson Computer Press.

Dillenbourg, P. (ed.) (1999). *Collaborative Learning: Cognitive and Computational Approaches*. Pergamon. Amsterdam.

Dillenbourg, P. (2007). "Flexibility in Macro-Scripts for Computer-Supported Collaborative Learning," *Journal of Computer Assisted Learning* (23)1, pp. 1-13.

Dochy, F. (1992). "Assessment of Prior Knowledge as a Determinant for Future Learning," Centre for Educational Technology and Innovation OTIC. Utrecht: Uitgeverij Lemma B.V.

Dochy, F. and G. Moerkerke. (1997). “Assessment as a Major Influence on Learning and Instruction,” *International Journal of Educational Research* (27)5, pp. 415-432.

Duffy, T. M., J. Lowyck, and D. H. Jonassen (eds.). (1993). *Designing Environments for Constructive Learning*. NATO ASI Series. Series F: Computer and Systems Sciences, (105). Berlin: Springer.

Dunne, E., N. Bennett, and C. Carré. (2000). “Skill Development in Higher Education and Employment,” in Coffield, F. (ed.) *Differing Visions of a Learning Society*, pp. 105-137. Bristol: Policy Press.

Duit, R. (1995). “The Constructivist View: A Fashionable and Fruitful Paradigm for Science Education Research and Practice,” in Steffe, P. and J. Gale (eds.) *Constructivism in Education*, pp. 271-286. Hillsdale, NJ: Erlbaum.

El-Sabaa, S. (2001). “The Skills and Career Path of an Effective Project Manager,” *International Journal of Project Management* 19(1), pp. 1-7.

Eraut, M. (2004). “Transfer of Knowledge between Education and Workplace Settings,” in Rainbird, H., A. Fuller, and A. Munro (eds.) *Workplace Learning in Context,* pp. 201–221. London: Routledge.

Fallows, S. and C. Steven (eds.). (2000) *Integrating key skills in higher education: employability, transferable skills and learning for life*, London: Kogan Page.

Faraj, S. and V. Sambamurthy (2006.) “Leadership of Information Systems Development Projects,” *IEEE Transactions on Engineering Management* (53)2, pp. 238- 249.

Feltovich, P. J., R. J. Spiro, and R. L. Coulson. (1993). “Learning, Teaching and Testing for Complex Conceptual Understanding,” in Frederiksen, N., R. J. Mislevy, and I. I. Bejar (eds.) *Test Theory for a New Generation of Tests,* Hillsdale, NJ: Erlbaum. pp. 181-217.

Fielding, N. (1993). Qualitative Interviewing. In N. Gilbert (ed.) Researching Social Life. London: SAGE Publications. 135-153.

Fritz, J.M. (1987) “A Pragmatic Approach to Systems Analysis and Design,” in Rigler, A. K., D. C. St. Clair (eds.) *Technical Symposium on Computer Science Education*, Proceedings of the eighteenth SIGCSE technical symposium on Computer science education, St. Louis, Missouri, United States. New York: ACM Press, pp. 127-131.

Geelan, D. (2006). *Undead Theories. Constructivism, Eclecticism, and Research in Education*. Rotterdam: Sense Publishers.

Gergen, K. J. (1995). “Social Construction and the Educational Process,” in Steffe, P. and J. Gale (eds.), *Constructivism in Education*, Hillsdale, NJ: Erlbaum, pp. 17-39.

Gillard, S. (2005). “Managing IT Projects: Communication Pitfalls and Bridges,” *Journal on Information Science* (31)1, pp. 37-43.

Green, L. (2003). “Projecting IT Education into the Real World,” Proceeding of the Fourth Conference on Information Technology Education. CITC4’03, October 16-18, 2003, Lafayette, Indiana, USA. New York: ACM Press, pp. 111-114.

Hakkarainen, K., T. Palonen, S. Paavola, and E. Lehtinen. (2004). *Communities of Networked Expertise: Professional and Educational Perspectives*. Amsterdam: Elsevier.

Hansen, S. (2004). “A Constructivist Approach to Project Assessment,“ *European Journal of Engineering Education* (29)2, pp. 211-220.

Helle, L., P. Tynjälä, and E. Olkinuora. (2006). “Project-Based Learning in Post-Secondary Education: Theory, Practice and Rubber Sling Shots,” *Higher Education* (51)2, pp. 287–314.

Helle, L., P. Tynjälä, K. Lonka, and E. Olkinuora. (2007). “Where’s the Learning in Work-Based Project Learning? Case Study in Information Systems Design” in R. Rinne, A. Heikkinen, and P. Salo (eds.) *Adult Education: Liberty, Fraternity, Equality*, Nordic Views on Lifelong Learning Turku: Finnish Educational Research Association, (pp. 297-321).

Helle, L., P. Tynjälä, E. Olkinuora, and K. Lonka. (2007b). “’Ain’t Nothing like a Real Thing: Motivation and Study Processes on Work-Based Project Course in Information Systems Design,” *British Journal of Educational Psychology* (77)2, pp. 397-411.

Jonassen, D., J. Strobel, and J. Gottdenker. (2005). “Model Building for Conceptual Change,” *Interactive Learning Environments* (13)1/2, pp. 15-37.

Jonassen, D. H. and J. Hernandez-Serrano. (2002). "Case-Based Reasoning and Instructional Design: Using Stories to Support Problem Solving," *Educational Technology and Development* (50)2, pp. 65-77.

Jones, C. (1999). *Software Project Management in the Twenty- First Century*, Software Productivity Research, Inc. Burlington, MA.

Jurison, J. (1999). "Software Project Management: The Manager's View," *Communications of Association for Information Systems* (2), Article 17.

Kezsbom, D., D. Schilling, and K. Edward. (1989). *Dynamic Project Management: A Practical Guide for Managers and Engineers*, New York: Wiley.

Lacity, M. C. and M. A. Janson. (1994). "Understanding Qualitative Data: A Framework of Text Analysis Methods," *Journal of Management Information Systems* (11)2, pp. 137-155.

Lave, J. and E. Wenger. (1991). *Situated Learning. Legitimate Peripheral Participation*, Cambridge: Cambridge University Press.

Lee, D. M. S., E. M. Trauth, and D. Farwell. (1995). "Critical Skills and Knowledge Requirements of IS Professionals: A Joint Academic/Industry Investigation," *MIS Quarterly* (19)3, pp. 313-340.

Lehtinen, E. and S. Repo, (1996), "Activity, Social Interaction, and Reflective Abstraction: Learning Advanced Mathematical Concepts in a Computer Environment" in Vosniadou, S., E. De Corte, R. Glaser and H. Mandl (eds.) *International Perspectives on the Design of Technology-Supported Learning Environments*, Mahwah, NJ: Erlbaum, pp.105-128.

Lehtinen, E. and E. Rui. (1996). "Computer-Supported Complex Learning: An Environment for Learning Experimental Methods and Statistical Inference," *Machine Mediated Learning* (5)3and4, pp. 149-175.

Leinhardt, G., K. McCarthy Young, and J. Merriman. (1995). "Integrating Professional Knowledge: The Theory of Practice and the Practice of Theory," *Learning and Instruction* (5)4, pp. 401-408.

Lonka, K. (1997). *Explorations of Constructive Processes in Student Learning*, University of Helsinki. Department of Psychology. Helsinki: Yliopistopaino.

Lonka, K. and K. Ahola. (1995). "Activating Instruction: How to Foster Study and Thinking Skills in Higher Education", *European Journal of Psychology of Education* 10, pp. 351-368.

Mandl, H., H. Gruber, and A. Renkl. (1996). "Communities of Practice Toward Expertise: Social Foundation of University Instruction" in Baltes, P. B. and U. M. Staudinger (eds.) *Interactive Minds. Life-Span Perspectives on the Social Foundation of Cognition,* Cambridge: Cambridge University Press, pp. 394-412.

Markovitz, J. and K. Messerrer. (2006). "Practice-Oriented Methods in Teaching and Learning in Higher Education: Theory and Empirical Evidence," in Tynjälä, P., J. Välimaa, and G. Boulton-Lewis (eds.) *Higher Education and Working Life. Collaborations, Confrontations and Challenges* Amsterdam: Elsevier, pp. 177-194.

Maqsood, M. and T. Javed. (2007). "Practicum in Software Project Management: An Endeavor to Effective and Pragmatic Software Project Management Education," *ESEC-FSE companion '07 : The Sixth Joint Meeting on European Software Engineering Conference and the ACM SIGSOFT symposium on the foundations of Software Engineering: Companion Papers.*

Moses, L., S. Fincher, and J. Caristi. (2000). "Teams work" (panel session) in Haller S. (ed.) *Proceedings of the 31st SIGCSE Technical Symposium on Computer Science Education*, March 7-12, Austin, USA. New York: ACM Press, pp. 421-422.

Muzio, E., D. Fisher, E. Thomas, and V. Peters. (2007). "Soft Skills Quantification (SSQ) for Project Manager Competencies," *Project Management Journal* (18)2, pp. 30-38.

Nicholas, J. (1994). *Managing Business and Engineering Projects: Concepts and Implementation*. Endkewood Cliffs, N.J. Prentice-Hall.

Oliver, S. R. and J. Dalbey. (1994). "A Software Development Process Laboratory for CS1 and CS2," *Proceedings of the 25th SIGCSE Symposium on Computer Science Education*, New York: ACM Press, pp. 169-173.

Phillips, D. C. (1995). "The Good, the Bad, and the Ugly: The Many Faces of Constructivism", *Educational Researcher* (24)7, pp. 5-12.

Pigford, D. V. (1992). "The Documentation and Evaluation of Team-Oriented Database Projects," *Proceedings of the 23rd Technical Symposium on Computer Science Education*, Kansas City, Missouri, United States. New York: ACM Press, pp. 28-33.

Pinto, J. and O. Kharbanda. (1996). "How to Fail in Project Management (Without Really Trying)," *Business Horizons* (39)2, p. 45.

Pirhonen, M. and R. Hämäläinen. (2005). *Oppimispoluille ohjaamassa. Eväitä oppimisprojektien ohjaajille*. [*Guiding towards learning: Resources for Instructors of Learning Projects*, in Finnish]. Jyväskylän ammattikorkeakoulun julkaisuja 50.

Prawat, R. (2000). "The Two Faces of Deweyan Pagmatism: Inductionism versus Social Constructivism," *Teachers College Record* (102)4, pp. 805-840.

Prawat, R. (1996). "Constructivisms, Modern and Postmodern," *Educational Psychologist* (31)3/4, pp. 215-225.

Rebelsky, S. A. and C. Flynt. (2000). "Real-World Program Design in CS2 The Roles of a Large-Scale, Multi-Group Class Project," *SIGCSE 2000*, Austin, TX, USA. New York: ACM Press, pp. 192-196.

Roberts, E. (2000). "Computing Education and the Information Technology Workforce," *SIGCSE* Bulletin (32)2, pp. 83-90.

Ross, J. and K. Ruhleder. (1993). "Preparing IS Professionals for a Rapidly Changing World: The Challenge for IS Education" in Tanniru, M.R. (ed.) *Proceedings of the 1993 Conference on Computer Personnel Research*, St Louis, Missouri, United States. New York: ACM Press, pp. 379–384.

Scott, T. J., L. H. Tichenor, R. B. Jr. Bisland, and J. H. Cross. (1994). "Team Dynamics in Student Programming Projects, *SIGSCE* (26)1), pp. 111-115.

Smith, B. and R. Dodds. (1997). *Developing Managers through Project-Based Learning*, Aldershot/Vermont: Gover.

Spiro, R. J., P. J. Feltovich, M. J. Jacobson, and R. L. Coulson. (1995). "Cognitive Flexibility, Constructivism, and Hypertext: Random Access Instruction for Advance Knowledge Acquisition in Ill-Structured Domains" in Steffe, P. and J. Gale (eds.) *Constructivism in Education* , Hillsdale, NJ: Erlbaum, pp. 85-108.

Steffe, L. P. (1995). "Alternative Epistemologies: An Educators Perspective" in P. Steffe and J. Gale (eds.) *Constructivism in Education* , Hillsdale, NJ: Erlbaum, pp. 489-523.

Stenström, M-L. (2006). "Polytecnic Graduates' Working-Life Skills and Expertise" in Tynjälä, P., J. Välimaa, and G. Boulton-Lewis (eds.) *Higher Education and Working Life. Collaborations, Confrontations and Challenges,* Amsterdam-Elsevier, pp. 89-102.

Sumner, M. (1987). "The Senior Information Systems Design Project Seminar," *Proceedings of the 18th SIGCSE Technical Symposium on Computer Science Education, ACM SIGCSE Bulletin* (19)1, pp. 2-8.

Sumner, M., D. Bock, and G. Giamartino. (2006). "Exploring the Linkage between the Characteristics of IT Project Leaders and Project Success," *Information Systems Management* (23)4, pp. 43-49.

Thayer, R. (1987). "Software Engineering Project Management: A Top-Down View," in Tutorial: *Software Engineering Project Management*, IEEE Computer Science Press. Los Alamitos, California, pp. 15-53.

Turner, R. and R. Müller. (2006). "Choosing Appropriate Project Managers: Matching Their Leadership Style to the Type of Project," Project Management Institute, Newton Square; USA.

Tynjälä, P. (1999). "Towards Expert Knowledge? A Comparison between a Constructivist and a Traditional Learning Environment in the University," *International Journal of Educational Research* (31)5, pp. 355-442.

Tynjälä, P. (2008a). "Perspectives into Learning at the Workplace", *Educational Research Review* (3)2, pp. 130-154.

Tynjälä, P. (2008b). "Connectivity and Transformation in Work-Related Learning. Theoretical Foundations" in Stenström, M-L and P. Tynjälä (eds.) *Towards Integration of Work and Learning. Strategies for Connectivity and Transformation*, Springer. pp. 11-37.

Tynjälä, P., V. Slotte, J. Nieminen, K. Lonka, and E. Olkinuora. (2006). "From University to Working Life: Graduates' Workplace Skills in Practice" in Tynjälä, P., J. Välimaa, and G. Boulton-Lewis (eds.) *Higher Education and Working Life: Collaborations, Confrontations and Challenges*, Amsterdam: Elsevier, pp. 73-88.

Tynjälä, P., J. Välimaa, and A. Sarja. (2003). "Pedagogical Perspectives on the Relationships between Higher Education and Working Life," *Higher Education* (46)2, pp. 147-166.

Väärälä, R. (1995). "Ammattikoulutus ja kvalifikaatiot" [Vocational Education and Qualifications, in Finnish]. Rovaniemi: Lapin yliopisto.

van Someren, M. W., P. Reimann, E. Boshuizen, and T. de Jong (eds.). (1998). *Learning with Multiple Representations*, Amsterdam: Pergamon.

Vartiainen, T. (2005). "Moral Conflicts in a Project Course in Information Systems Education," Dissertation thesis, Department of Computer Science and Information Systems, University of Jyväskylä.

Vermunt, J. (1995), "Process-Oriented Instruction in Learning and Thinking Strategies," *European Journal of Psychology of Education* 10, 325-349.

Verner J. M., S. P. Overmyer, and K. W. McCain. (1999). "In the 25 Years since The Mythical Man-Month What Have We Learned about Project Management?" *Information and Software Technology* (41), pp. 1021–1026.

von Glasersfeld, E. (1984). "An Introduction to Radical Constructivism," in Watzlawick, P. (ed.) *The Invented Reality. How Do We Know What We Believe to Know? Contributions to Constructivism*, New York: Norton, pp. 17-40.

von Glasersfeld, E. (1995a). "A Constructivist Approach to Teaching," in Steffe, P. and J. Gale (eds.) *Constructivism in Education*, Hillsdale, NJ: Erlbaum, pp. 3-15.

von Glasersfeld, E. (1995b). "Sensory Experience, Abstraction, and Teaching," in Steffe P. and J. Gale (eds.) *Constructivism in Education*, Hillsdale, NJ: Erlbaum, pp. 369-383.

von Glasersfeld, E. (2007), *Key Works In Radical Constructivism*, Larochelle, M. (ed.) Rotterdam: Sense Publishers.

von Hellens, L., S. Wong, and J. Orr. (2000). "IT Skill Requirements: Perspectives from Industry," Proceedings of the 11th ACIS, 8-10 December.

von Wright, J. (1992). "Reflections on Reflection," *Learning and Instruction* (2)1, pp. 59-68.

Vosniadou, S. (1992a). "Knowledge Acquisition and Conceptual Change," *Applied Psychology: An International Review* (41), pp. 347-357.

Vosniadou, S. (1992b). "Fostering Conceptual Change: The Role of Computer-Based Environments," in de Corte, E., M. C. Linn, H. Mandl, and L. Verschaffel (eds.), *Computer-Based Learning Environments And Problem Solving,* Berlin: Springer, pp. 149-162.

Vosniadou, S. (1994). "Capturing and Modeling the Process of Conceptual Change," *Learning and Instruction* (4)1, pp. 45-69.

Wateridge, J. (1997). "Training for IS/IT Project Managers: A Way Forward," *International Journal of Project Management* (15)5, pp. 283-288.

Watson, H. J. and M. W. Huber. (2000). "Innovative Ways to Connect Information Systems Programs to the Business Community," *Communications of the AIS* (3) Article 11.

Xia, W. and G. Lee. (2004). "Grasping the Complexity of IS Development Projects," *Communications of the ACM* (47)5, pp. 69-74.

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