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## Project-based Learning - An Emergent Framework for Designing Courses

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# Project-based Learning– an Emergent Framework for Designing Courses

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## Abstract

In this paper we elaborate on a framework, a set of guidelines, for teachers when designing project based courses. The emergent framework presented in this paper will focus on six themes: (1) overall course design, (2) project task, (3) project group, (4) examination, (5) feedback and (6) course evaluation and improvement and is initially grounded in theory and practice. The framework elaborated in this paper should support teachers' development of a professional autonomy within the norms of a professional group and an active curriculum.

**Keywords:** Learning, student centred education, information systems education, project, course design, framework

## 1. INTRODUCTION

Working in project groups is one of the most common forms of student centred education (SCE). In the information systems education area the purpose of using projects as a part of education is at least twofold. On one hand it has several positive learning effects (see Section 2) and on the other hand it prepares the student to work in a professional environment where information systems are designed, developed, implemented, adapted and maintained in projects. The need for e.g. interpersonal skills, communication, problem solving, professionalism and creativity are increasing in such environment (see e.g. Gupta and Wachter, 1998). One of the main problems with project based courses is that it is individuals who gain

qualifications, not groups. As a university and a specific teacher one must find a way to allocate marks fairly to individual students (Gibbs, 1995). The challenge when marking and examining student project work in courses is one of the reasons why we elaborate on a framework, a set of guidelines, for teachers when designing project based courses in this paper. The development context for the framework is a project focusing assessment, examination and feedback (described in Section 3).

University teaching has more or less been considered as a private property of an individual teacher, with substantive individual freedom (Handal, 1999). The proposed and emergent framework in this paper is one step in order to support teachers to act

within the norms of a professional group (professional autonomy) and an active curriculum (cf. Handal, 1999) in order to design high quality courses.

Significant themes and concepts within the framework are project, learning, assessment, examination and feedback. According to Packendorff (1995) a project is a temporary organization with a number of project members who are interacting during a limited time in order to reach a goal. Project based learning can be understood as a perspective and a way of organising education to support learning and can also be seen as an alternative to Problem Based Learning (PBL) (Abrant Dahlgren and Dahlgren, 2000; Gibbs, 1995). We identify the CDIO (Conceive—Design—Implement—Operate) initiative for the engineering discipline (Bankel et al., 2003; The CDIO Initiative, 2006) as a corresponding alternative to PBL. PBL, CDIO and project based learning are examples of SCE forms, which emphasize learning in context, elaboration of knowledge through social interaction, and meta-cognitive reasoning together with self-directed learning (Gibbs, 1995). In the latter approach project orientation (with focus on milestones, organising support tools, evaluation etc.) is more emphasized than in PBL. The learning objectives that we use also tend to follow a certain course rather than whole semesters as in PBL; we also use project groups with different number of students (not necessarily 6 to 8 students as in PBL) and have more active teachers in the problem searching and definition phase than PBL. CDIO is a general approach in engineering and has several similarities compared to the project based learning discussed in this paper. We have identified similarities concerning aspects of for example the CDIO initiative's concept to provide students with an education stressing the technical fundamentals, and prepare students to be successful in the role of developing systems and products (Bankel et al., 2003). In the subject area of information systems we focus on organisational fundamentals and technical fundamentals side by side and focus on the development of information systems. This is also identified by e.g. Gupta and Wachter (1998) and (Clear et al., 2001) discussing capstone courses ("a capstone course may include a project or "research-type" experience [and a] relatively structured assignments, extremely open

ended assignments or student created assignments" (Clear et al, 2001, p. 94).

The objective of this paper is to elaborate on an emergent framework, a set of guidelines, for teachers when designing project based courses. The main subject area for courses is information systems, informatics or computer science, but the framework can be related to other subject areas and disciplines working with projects (e.g. business administration). The emergent framework is initially grounded in theory and practice, but this is a part of a continuous development process with further testing, refinement and verification.

A short description of project based learning will follow (Section 2). In the next section our development project will be introduced (Section 3), followed by the research approach (Section 4). Then the emergent framework for designing project based courses will be presented (Section 5). Finally a concluding discussion (Section 6), some directions for future research (Section 7) and acknowledgements (Section 8) will be presented.

## 2. PROJECT BASED LEARNING

### 2.1. Project as a Phenomenon

A project can be defined as "an enterprise carefully planned to achieve a particular aim" (Oxford Dictionary, 1999). A common set of project characteristics can be listed as follows: (1) A project is a unique task, (2) has a predetermined date of delivery, (3) is subject to one or several performance goals (such as resource usage and quality), and (4) consists of a number of interdependent activities (Kreiner, 1995).

However, in recent years the perspective on projects has changed. Several scholars (e.g. Kreiner, 1995; Lundin and Söderholm, 1995; Packendorff, 1995) use the term "temporary organisations" as an underlying metaphor to illustrate that a certain number of people interact for a limited time to achieve a goal. The traditional metaphor is that a project is a tool – a tool to reach goals at a higher level.

What we think is particularly interesting with this latter perspective on projects (from our educational arena) is that it clearly emphasizes the role of expectations, collective ac-

tions, organising, actors' roles, relations, and learning. "The Temporary Organisation" perspective also acknowledges a project as a context dependent and social phenomenon (Kreiner, 1995). This corresponds to several ideas in hermeneutics and accentuates the significance of a context, the subjective, and the inter subjective understanding (Melin and Cronholm, 2004).

## 2.2. Learning in Project-Based Courses

In the present project we consider knowledge as a construction and a self-evident part of a context (Lave and Wenger, 1991). This is a constructivist point of departure (Berger and Luckmann, 1966). Every actor creates his/her knowledge and structure, and makes sense of theories, and parts of their reality in his/her own way. Our approach to learning follows Ramsden's (2003) description of the concept. We focus on an approach to learning based on how students learn and what they learn; and our task as teachers is to, context dependently, organise for learning to take place. Students then experience the subject matter heterogeneously and structure their own knowledge (Berger and Luckmann, 1966; Lave and Wenger, 1991; Ramsden, 2003). We also try to encourage a holistic and deep approach to learning – a meaning orientation (Ramsden, 2003), with a focus "on the whole in relation to the parts" and "what the tasks are about". Students' analytical skills, creativity, and self-awareness are highly ranked on our agenda and have a salient position in the emergent framework presented in Section 5. It is therefore central for us to organise tasks in current courses that give students opportunities to relate new knowledge to previous knowledge, and to relate theoretical ideas to everyday experience and real life situations (Ramsden, 2003). In the development project presented in Section 3, and the emergent framework, we take this stand point as a point of departure and like to be more student oriented, take the student's requirements into account, and their construction of knowledge as a basis when designing courses. To use a project as a perspective and as a way of working can be a fruitful approach in order to create such an arena, where the student can train their abilities to hold dialogues, interact, observe, listen to project members' perspectives,

make judgements, solve problems, construct and assess their knowledge etc. Our view of the construction of knowledge, learning in context, social interaction in project groups, and examination corresponds to core characteristics in PBL (Abrant Dahlgren and Dahlgren, 2002).

The project is also an arena where we can create a situation that can be authentic (genuine in some way; a real-life scenario), for example, to take or create, products and processes that are present in trade and industry. The situation where learning takes place is considered to be central (Lave and Wenger, 1991). In these situations it is also possible to use project management tools such as milestones, group contracts, different templates and tools etc.

The need for resources when designing courses with the profile suggested in this paper is also discussed by e.g. Gupta and Wachter (1998) and Clear et al. (2001). In the former source we can identify several "guidelines for success" when designing information systems courses. A subset of these guidelines for success are: to plan and to organise the course content well in advance, to ensure that the cases used are comprehensive and include a business context, to build an atmosphere of trust and respect between teachers and students and between students in order to make high quality critique processes.

## 2.3. Examination and Feedback in Project-based Courses

Examination is a central part in the emergent framework focused in this paper. Jaques et al. (1989) present a range of examination methods that can be chosen when designing courses. Such methods are often seen as a way of checking what students have learnt and "a little more". Some functions of the examination methods are: provide students with opportunities to demonstrate what they are able to do, by measuring the success of the course (in terms of outcome), testing the students' skills to perform under certain conditions, acting as a filter to determine students' progress, to motivate students, revealing and maintaining standards, and giving students and tutors feedback on how well the students have learnt (incl. strengths and weaknesses). Examination can be directed towards individu-

als or groups. When the examination is directed to groups the risk of the free rider syndrome is a well-known aspect. Assessing group work is therefore a challenging task for teachers (Gibbs, 1995)

Examination, as defined by Rowntree (in: Ramsden, 2003), is about knowing our students and the quality of learning. We try to understand students in all their complexity and their potential as learners of the subject matter (Ramsden, 2003). The examination of students learning should take both these dimensions into account and be a platform to mark students' progress and performance (Ramsden, 2003). We can, for example as teachers, mark the students' ability to recall facts, apply frameworks, perspectives or theories, to analyze different processes or phenomena, to make syntheses of different methods or theories, and to evaluate their own, or others knowledge constructions. This list is based on the taxonomy presented by Bloom et al. (1956). The latter categories are perceived as more advanced.

We would also like to highlight the importance of feedback to students when examination and grading has been made. The mark itself should not be the only feedback from a teacher. Feedback to students, from teachers and/or other students is central to establishing a learning environment. It is impossible to overstate the feedback and effective comments on students' progress when discussing the organising of courses and examination (Melin and Cronholm, 2004; Ramsden, 2003). The importance of feedback is one reason why this area is highlighted as one theme in the emergent framework in Section 5.

### 3. OUR DEVELOPMENT PROJECT

The context for the framework presented in this paper is a pedagogical development project at the Department of Computer and Information Science, Linköping University, Sweden. The project started in January 2005 and ends in December 2006. The title of the project is: "Establishing Project Oriented Student Work - Emphasizing Assessment, Examination and Feedback".

In the project we evaluate, improve and develop new assessment, examination and feedback forms for students working in project settings. Assessment and examina-

tion forms are adapted for what we define as "project oriented student work". We develop capabilities to assess and examine student work in both individual work and group work and to give meaningful, high quality, feedback on students' achievements. In order to achieve that we, as a teaching unit, identified a need to be more aware of, and have skills to design, organise and evaluate learning and teaching. We also identified a need to take both the learning process (recurrent examination and feedback during a particular course) and the product (the learning "outcome" at the end of a particular course) into account. One major objective with the project is to establish a framework for assessment, examination and feedback of student work within the Information Systems/Informatics area and our project oriented undergraduate courses (candidate and master level in the Swedish education system). This paper will focus on such a framework for designing courses. The framework is emerging, based on theoretical (a literature review partially presented in section 2) and practical experiences. The practical experiences are based on working with the emergent framework in three pilot (prototype) courses in the information system area; an introductory systems development course, a second year method and CASE tools course and a fourth year electronic commerce course. All courses are compulsory courses in a four year study program in information systems. Further evaluating and testing the framework in regular course design is, thus, a future activity.

One important perspective in the framework is the striving for improving courses and also teachers learning when improving. The aspect of learning and improvement can be expressed in many ways. Different cyclic illustrations are used in both fields (see for example PMBOK Guide, PMI, 2004). Here we choose to express learning and improving based on Kolb's learning cycle (1984) (focus on individuals) also illustrated by Shewhart and Deming (Deming, 1986, 1993) (focus on organisations) as the PDCA (or in 1993 as PDSA; "S" stands for study) cycle.

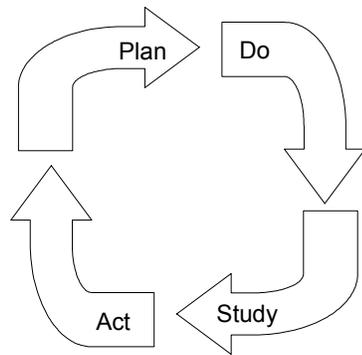


Figure 1 Deming's PDSA cycle (Deming, 1993)

#### 4. RESEARCH APPROACH

The research approach applied in this paper is rather straightforward and explorative (cf. Strauss and Corbin, 1998). We have identified a need for guidelines when teachers should design project based courses. The need is grounded in theory and practice and there is a challenge in marking individual achievements in project groups. In order to generate the emergent framework presented in this paper we have worked systematically by analyzing both our own practice (with its shortcomings and merits), generating categories with the support of grounded theory (Glaser and Strauss, 1967; Strauss and Corbin, 1998), and analyzing theories of learning (e.g. PBL, SCE approaches, CDIO) and projects. The successful practice and the appropriate theory have then been integrated in the emergent framework. The so called successful practice in this paper consisted of pilot courses (described briefly in section 3) where teachers used a logbook to document their own experiences. Notes from logbooks (e.g. initiatives that worked well and reasons why), interviews with teachers and a seminar with student representatives, together with data from formal course evaluations then served as a basis, together with theory, for generating and verifying categories (a coding process based on Strauss and Corbin, 1998) mentioned above. When presenting the framework references are given to theory and practice as examples.

#### 5. AN EMERGENT FRAMEWORK FOR DESIGNING COURSES

Below we present the emergent framework as a result from the project outlined above.

The framework is divided into six themes: (1) overall course design, (2) project task, (3) project group, (4) examination, (5) feedback and (6) course evaluation and improvement.

##### 5.1. Overall Course Design

In the overall design of a course a teacher should consider the following aspects:

- The learning objectives should be clearly stated by the teacher and known by the students. This aspect of course design is important according to practice (student standpoints in our project) and theory (see Gibbs, 1995).
- The design of the course as a whole should give a stimulus to:
  - Student activity.
  - To take students own experiences and knowledge into account.
  - To focus on a learning process and student qualifications (cf. e.g. perspectives in SCE (Gibbs, 1995; Melin and Cronholm, 2004)).
  - An improvement of the curriculum that serves as a basis for the course.
- The course activities should stimulate thoughts and skills on a meta-cognitive level (reflection and awareness of underlying principles and patterns in problem solving, students own thinking and learning) (cf. basic assumptions in PBL, e.g. Ramsden, 2003).
- The course design can include elements of organizing students learning outside student-teacher contact hours (by for example supplying scheduled premises, computers, and projectors for student project work).
- The design of the course should, from a teacher perspective, be based upon a reflection over the last time the course was run (if applicable) and should address the change needs addressed at that time (the outcome of the evaluation and improvement in Section 5.6). The distinct improvement perspective is also a part of project management

(PMBOK Guide PMI, 2004) and e.g. the CDIO initiative (Bankel et al., 2003).

- The teacher should keep a logbook over the effects, experiences of the course design and possible improvements when performing the education activities.

## 5.2. Project Task

The project task is a core aspect in a project based course. The project tasks that are present in the information systems courses in the subject area described here are more defined by the teacher compared to for example pure PBL descriptions. The students have some possibilities to shape and frame the tasks to fit their own interests and experiences, but not as much as in PBL. The project tasks should also be:

- Relevant and authentic – the project task and the project outcome should be relevant in order to achieve basic skills in the curriculum and in a future profession (e.g. as a system developer, IT- or management consultant, project leader) and reflect authentic situations (for example problem solving in an ERP system implementation project). The importance of relevance is grounded in theory (e.g. in pragmatism and roots of PBL and SCE (Ramsden, 2003) and in e.g. Gupta and Wachter, 1998) and is highly ranked by students and teachers in our development project. When making the project task explicit it is also important to define the degree of process and/or product focus in the course. The need for making the process and product dimension of courses of this kind is discussed by Clear et al. (2001).
- Introduced by teachers in text and orally in order to e.g. address different learning styles.
- Based on a certain or interval space of time. It is also important to make the study points explicit. We have identified this as an important point in order to have an influence on student expectations of time needed to work with a particular task. Time management and plans are also im-

portant parts of the project work setting and the student skills that we aim to achieve (PMBOK Guide PMI, 2004).

- Followed by arguments from the teacher why the present task is preferable to work with in the course.
- Flexible enough to adjust to student interests and experiences.

The overall course design has a clear message – to organize the course process and content well in advance. (cf. Gupta and Wachter, 1998).

## 5.3. Project Group

- The composition of projects groups should be based on principles that are made explicit by the teacher. Doubtfulness concerning this aspect of project groups has a negative influence on project results according to our previous practice.
- Project group performance should be followed up by the teacher and the students in order to reduce the free rider syndrome and to assure law and order when examining individual achievements (c.f. Gibbs, 1995).
- Students' achievements in project groups should never be the only foundation for examining students. It should always be combined by measuring students' individual achievements in other examination forms (written examinations, individual essays etc.). The importance of this aspect is grounded in our experience when working with pilot courses in the present development project. To stimulate different student learning styles is also important (Ramsden, 1995).

## 5.4. Examination

- The design of the examination and its organizing should be explicitly described in a course description/syllabus and orally by the teacher together with the present marking interval.
- Examination should be based on a predefined set of criteria (describing for example the distinguishing features of a high quality work in terms

of problem handling, analysis, conclusions etc.).

- The teacher elaborates a set of criteria as a ground for examination.
- The set of criteria and other foundations for examination is made explicit for students in project task preconditions (cf. e.g. Boud, 1998 and Gibbs, 1995).
- The set of criteria as a ground for examination should be based on the curriculum and learning objectives for a specific course.

A course should always include at least two different forms of examination in order to address different student learning styles and reduce the risk of free riders (see above).

- At least one examination in a course should measure an individual student's achievement.
- Examination should be reliable, fair and impartial.
- Examination should maintain a reciprocal trust between the teacher and the student.
- Examination should be an opportunity for the students to learn more.
- Examination should be relevant compared with the present curriculum, syllabus and other intentions expressed by the subject area.
- Examination should address national equality of rights.

### 5.5. Feedback

Feedback, as interpreted here, can on one hand be apart of a learning and project process, for example related to achieving certain project milestones or other deliverables, and on the other hand be an explicit part of the teacher's examination and communication with the student besides a particular mark. The importance of feedback is grounded in theory (e.g. Ramsden, 2003) and in the present development project (among students and teachers). Following Ramsden we also think that it is impossible to overstate the feedback and effective comments on students' progress when discussing the organizing of courses and ex-

amination. The need for feedback in supervision is also highlighted by Clear et al. (2001).

- The expected kind of feedback should be expressed by the teacher in the prerequisites of a particular task.
- The point of time for feedback should always be expressed by the teacher.
- Feedback should:
  - Be critical, make a difference, and be reflective.
  - Express constructive criticism and contain positive and negative aspects of the achievement examined.
  - Be qualitative in a sense that it should not only contain the expression of a particular mark. It should contain estimation from the responsible teacher (examiner).
  - Integrate different stages or phases in a course (if applicable).
- The feedback can stimulate to a continuous dialogue between the student and the teacher or with a student who is on the same course as a part of a learning process.

All feedback activities should encourage a holistic and deep approach to learning – a meaning orientation (Ramsden, 2003) as discussed in Section 2, with a focus "on the whole in relation to the parts" and "what the tasks are about". Students' analytical skills, creativity, and self-awareness should be preferential together with a pragmatic point of departure.

We also identify the need to build an atmosphere of trust and respect between teachers and students and between students (cf. Gupta and Wachter, 1998) in order to make high quality critique processes (discussed above).

Student to student feedback is also an important aspect, not studied in this paper.

## 5.6. Course Evaluation and Improvement

Evaluations of courses are compulsory. Evaluations are of three types:

- "Muddy Cards" evaluation performed in the middle of the course (student fill in cards with pros. and cons.).
- An evaluation performed from a teacher perspective. A joint action between several teachers (if applicable) in a subject area. The evaluation should relate to the Muddy Cards evaluation performed in the middle of the course and also be performed when the course has ended.
- An evaluation performed based on a student perspective at the end of the course.

The input from the evaluation should serve as a basis for improvement of the present course. The improvement activities become a part of the overall course design described in Section 5.1 and relate to Deming's (1993) PDSA cycle illustrated in Figure 1.

## 6. CONCLUDING DISCUSSION

In this paper we have presented an emergent framework, a set of guidelines, for teachers when designing project based courses. The framework consists of six themes: (1) overall course design, (2) project task, (3) project group, (4) examination, (5) feedback and (6) course evaluation and improvement. The learning and continuous improvement and process perspective is evident in the framework. The sets of criteria when examining students are also an important cornerstone when trying to be explicit concerning basic issues and prerequisites in project based courses.

The framework elaborated in this paper should support teachers' development of a professional autonomy within the norms of a professional group and an active curriculum. Of course there is a balance between individual freedom ("to do what I want as a teacher") and professional autonomy (cf. Handal, 1999 above) when using a set of guidelines in a framework for teachers when designing courses. Teachers' creativity, as individuals, must be maintained when, at the same time, using colleagues as critical

friends. The degree of professional autonomy and individual freedom versus the framework as guide to develop courses can also be related to the skills and experience of a specific teacher who makes use of the framework. Maybe we have a possible variation in the need of support from a framework when a teacher is a novice versus an expert in teaching.

Our experiences using the framework so far, based on the pilot courses (described in section 3) is that it is valuable for teachers when designing information systems courses. There are also strong indications that the framework has positive effects on the quality of the courses. In the formal course evaluations the students' have highlighted a clear course design, high student activity, relevant and authentic project tasks, explicit project group work conditions, a variation in examination forms based on an explicit set of criteria, and high quality feedback from the teacher.

The framework that we present is probably not dedicated only to project based courses in the information system subject area. This question, however, is an issue for future research.

## 7. FUTURE RESEARCH AND LIMITATIONS

Further refinement of the emergent framework is needed. Evaluation, verification and tests of the framework in regular course design are important future activities. Analytical categories can be more mature and additionally grounded also in theory (e.g. learning and project management). The specific organizing of projects is thoroughly dealt with by e.g. Clear et al. (2001) and is a source for future research when refining the framework more.

The framework can also be presented more suitable for its final purpose (graphically etc.) and related to courses in other subject areas. The latter aspect is needed in order to generalize the results to other subject areas.

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