

LESSONS LEARNED FROM DEVELOPING AND OPERATING A LARGE-SCALE PROJECT COURSE

Elisabeth Saalman

Chalmers University of Technology, Göteborg, Sweden

Lena Peterson

Chalmers University of Technology, Göteborg, Sweden

Johan Malmqvist

Chalmers University of Technology, Göteborg, Sweden

ABSTRACT

In 2004, Chalmers University of Technology in Göteborg, Sweden, decided to develop a project-based course for third-year students enrolled in its five-year engineering programmes. The motives were (a) that many of these programmes lacked a project course aimed at developing skills in project planning, teamwork and communication prior to the fifth-year master thesis project, and (b) that the introduction of a Bologna framework-style 3+2 education required the introduction of a bachelor thesis project. The project course was offered for the first time in spring 2007.

The aims of the Chalmers project course are that the students should integrate, deepen and develop knowledge and competency acquired during the first three study years. The course also aims to give the students good competencies to participate in project teams, using a critical and reflecting way of addressing and solving the project task. The project course is a large-scale endeavour: The course is compulsory for the students of fourteen "Civilingenjör" (MSc in Engineering) programmes and the Architecture programme. Each year, around 900 students are enrolled, working on 200 projects in many different areas, ranging from fundamental physics to architecture. The course size is 15 ECTS credits. A large number of faculty and staff are involved – teachers, administrative staff, librarians, linguistic staff etc. The course is very complex with all its different course elements that need to be coordinated.

The aim of the paper is to describe the development process of the project course, account for the course design, including the intended learning outcomes, the teaching approach and the assessment schema and to evaluate the experience from running the courses focusing on challenges deriving from the scale of the course, and from assessment of team-based project courses.

The project course has been carefully evaluated during its first two years. The evaluation results show that there have been problems with to provide clear and consistent information to students and staff and to clarify roles and responsibilities. Despite these information issues the students have a highly positive attitude towards the project course. Also the teachers are very satisfied with the quality and conduct of the students project work.

KEYWORDS

Project course, large-scale, generic competencies, assessment, engineering education

INTRODUCTION

Chalmers University of Technology has started a project course for all third year engineering students. The motives for starting the course were that many of Chalmers engineering programmes lacked a project course aiming at develop skills in project planning, teamwork and communication prior to the master thesis project, and that the introduction of a Bologna framework-style 3+2 year education required the introduction of a bachelor thesis project.

The aims of the Chalmers project course are that the students should integrate, deepen and develop knowledge and skills within some part of the field of study. The course further aims to develop the students' abilities to work using a critical and reflecting way of addressing and solving the project task, and to give the students the competencies to work as engineers in a scientific way of working and finding solutions. The project course is also used to support the development of the students' "generic competencies", such as the abilities to communicate and to work in teams are trained. A certain project of their own choice is the main vehicle for developing these knowledge and skills.

This Chalmers project course was offered for the first time in spring 2007. Fifteen education programmes at Chalmers are involved in the project course and about 900 students enrolled in the course last spring (2008). The students could choose among more than 200 projects in many different areas. There is also a lot of staff involved in this very large course – programme chairs, teachers (supervisors and examiners), administrative staff, librarians, linguistic staff, etc. The course is complex with all its different moments that need to be coordinated

The aim of this paper is to explore the challenges involved with starting and executing a large-scale project course. More specifically, we aim to

- Describe the development process of the project course.
- Account for the course design, including intended learning outcomes, teaching approach and assessment. In particular the way in which learning of generic competencies is integrated is discussed.
- Evaluate the experience from running the courses focusing on challenges deriving from the scale of the course, and on assessment of team-based project courses.

The remainder of the paper is structured as follows: We start by accounting for some related work in order to position the current paper. This is followed by a brief account for the course development process and the major design issues involved. We then describe the course including aspects such as intended learning outcomes, the teaching approach and the assessment. This is followed by a discussion of the evaluations that have been conducted, including teacher, student and administrator perspectives. Finally, conclusions are listed.

RELATED WORK

Project-based courses have become increasingly popular in engineering education during the last decades. A well-known example is Stanford's ME210: Mechatronic System Design project course [1]. At some universities, such as Aalborg University in Denmark, project work accounts for as much as 50% of the study time [2]. For a CDIO-based programme, CDIO Standard Five suggests that an engineering curriculum should include at least two design-implement experiences [3].

Underlying this trend is the growing insight that projects are essential for students to develop the key engineering competences of developing, implementing and operating product, processes, and systems. In addition, team-based project-based courses provide a natural

setting in which to teach generic competencies, such as teamwork and communication skills. From the perspective of fundamentals, realistic projects strengthen the foundation upon which deeper conceptual understanding of disciplinary and multidisciplinary knowledge can be built [3].

There exists a multitude of publications describing single project-based courses, highlighting some innovative aspect, such as the use of an industry-style project control model [4], a virtual collaboration environment that supports multinational student teams [5], or peer-based assessment [6].

However, surveys of project courses [7, 8] point out some recurring challenges involved with organizing project-based education, including assessment schemes that consider the multitude of learning outcomes that often characterize project courses, design of projects, the need for different teaching practices and competence, cost-effectiveness and scalability for large student groups. The course described in the paper posed particular challenges with respect to assessment and scalability.

DEVELOPMENT PROCESS AND DESIGN ISSUES

In this section, we discuss the development process of the course and some of the design issues that were particularly challenging to resolve. As stated above, the project course was given for the first time in spring 2007. The motives for starting the course were that many of Chalmers' engineering programmes lacked a project course aiming at develop skills in project planning, teamwork and communication prior to the fifth-year master thesis project, and that the introduction of a Bologna framework-style 3+2 education required the introduction of a bachelor thesis project.

These new needs motivated a common approach, despite the fact that Chalmers programmes have varying goals and pre-knowledge in project work and generic competencies. Thus, the development team was mainly composed by the programme chairs for Chalmers "Civilingenjör" and Architecture programmes, at times complemented by staff from the Centre for Language and Communication. The project leader was the dean of education for the "Civilingenjör" programmes. The development team met bi-weekly during the Fall of 2006.

The development considered in a fundamental way many aspects of a project course, including aims, intended learning outcomes, teaching and learning experiences, assessment, administrative procedures etc. This said, the development was not done entirely from scratch; it was possible to re-use certain elements from programmes that had recently introduced new project courses. Such elements included the notion of a "contract" between the students in a project group, regulating their aims, roles and responsibilities, the requirement for a relatively extensive planning report and parts of the assessment approach.

Let us now consider a few of the design issues that led to most discussion:

Common set of learning outcomes. As indicated above, a project-based course typically aims to develop disciplinary knowledge as well as generic competencies. Some project courses have very extensive sets of learning outcomes. Kovacevic [9] reports on a project course with ca 15 defined learning outcomes including "classic" generic competencies such as written and oral communication and teamwork skills but also creativity, business knowledge awareness, intellectual property rights, use of communication technology, decision-making etc. Some teachers may still feel that they need to address even more issues; the role of technology in society, entrepreneurship, a tendency which is strengthened if there is only one team-based project course in the curriculum. However, it became clear that in the present context - the large number and differing profile of programmes - a few

select generic competencies should be focused. They were chosen to be problem formulation, information search, planning, teamwork, and written and oral communication. The selection reflected both the basic requirements on Bachelor of Science/Engineering degrees in the Swedish Higher Education Ordinance [10] and the common denominator amongst the programmes. Some programmes have included a few additional learning outcomes in the project course, as discussed below. However, Chalmers programmes with higher ambitions with respect to generic competencies generally need to adapt a programme-level perspective, allocating generic competencies that are not addressed in the current course to other courses.

Assessment. The intended learning outcomes thus could start from a platform provided by the Swedish Higher Education Ordinance [10]. However, the Ordinance does not state how to teach or assess a particular learning outcome. It proved very challenging to identify the connection between the learning outcomes and various components of the assessment. The discussion was conducted on multiple levels: Should there be “graded” grades of or only pass/fail? What assessment methods were relevant for each learning outcome and how should they be weighted? How should the individual contributions be assessed and weighted? Resolving these issues and developing the assessment scheme was a major part of the course development.

Dual goals: Team-based project work and independent work. The course further had to meet two goals: The course was not only going to be a team-based project as part of a five-year engineering degree programme. It was also going to serve as the 15 ECTS credits independent work that demonstrates that the student has the skills required to work independently in the field, which is part of the requirements for a Bachelor of Science degree according to the Swedish Higher Education Ordinance [10]. Thus, the project and its documentation had to be designed in such a way that the individual’s contribution to the project result could be identified. The project group size was discussed: what is the minimal group size for training teamwork, what is the maximum group size if individual contributions are to be distinguishable? The assessment scheme was designed to enable this distinction. In the end, groups with 3-6 students were permitted.

Project selection and team composition. It was debated whether to let students form teams themselves which would then select a project, or if students should individually choose a project, and then the team be composed by a teacher (the course administrator). The latter approach was chosen in order to force students to work in project groups with students that they had not worked with before, potentially from another programme. The aim was to strengthen the multidisciplinary collaboration dimension of the project course.

The nature and extent of generic competencies training. The issue was here the programme’s differing starting points. Some of Chalmers’ programmes have ambitious approaches for integrating training of generic competencies in several courses during the first three years, whereas other programmes have very few such elements. The resolution was the agreement on a common set of generic competencies that are trained in the project course, including problem formulation, planning, teamwork and oral and written communication. The circumstance that students from some programmes have a stronger background in generic competencies was addressed by making some generic competency learning experiences voluntary, and by enabling programmes to define additional generic competency learning that build on the common set. Examples include scientific methodology and group dynamics.

Language. It was discussed whether it should be compulsory to write the project report in Swedish or if also English would be permitted, reflecting that many of Chalmers faculty are international, and that a bachelor thesis written in English might be used as a merit when applying for graduate education abroad. However, it was decided to stick strictly to Swedish, partly to ensure that each student writes at least one long report in Swedish during his/her

education (of which the last two years are taught entirely in English), partly due to the resources needed to provide linguistic consultation in English for such a large student group.

COURSE DESIGN

Introduction

The project course is a large-scale endeavour: Fourteen “Civilingenjör” (MSc in Engineering) programmes and the Architecture programme at Chalmers offer the project course. The programmes are Architecture, Architecture and Engineering, Automation and Mechatronics Engineering, Bioengineering, Chemical Engineering, Chemical Engineering with Engineering Physics, Civil Engineering, Computer Science and Engineering, Electrical Engineering, Engineering Mathematics, Engineering Physics, Industrial Design Engineering, Industrial Engineering and Management, Mechanical Engineering, and Software Engineering.

The projects are proposed by all of Chalmers 16 departments. The number of students is approximately 900, working on 200 projects in many different areas. The course size is 15 ECTS credits.

A large number of faculty and staff are involved – teachers, administrative staff, librarians, linguistic staff etc. The roles and responsibilities include:

- The persons responsible for Chalmers education programmes (the programme chairs) are responsible for the intended learning outcomes and contents, for coordination, and for selection of projects for the individual programme. In some programmes, a dedicated person coordinates the programme’s projects.
- The supervisors give instructions to and guide the project groups and judge the quality of the projects. The supervisors have a very central role during the whole project course.
- The examiners and the supervisors are in cooperation responsible for the course assessment.
- The teachers, supervisors and librarians from Chalmers library and Centre for Language and Communication are responsible for the generic competencies course elements. The language department also offers new supervisors at Chalmers to join a supervision course as a help to guide the students in the project work.
- The educational administrators at each programme act as examiners of the generic competency learning experiences. They also initiate and collect the course evaluations at the various programmes.
- Administrative staff at Chalmers’ student centres are involved during the whole project course concerning admission, information, selection of projects, allocation of projects, documentation of compulsory course elements in the course.

More information about the course (in Swedish) can be found at [11].

Course aim and intended learning outcomes

As stated above, the aims of the Chalmers project course are that the students should integrate, deepen and develop knowledge and skills within some part of the field of study. The course further aims to develop the student’s abilities to work using a critical and reflecting way of formulating, creating, evaluating, documenting, presenting and defending the solution to the project task. A certain project of their own choice is the main vehicle for developing these knowledge and skills.

More specifically, the intended learning outcomes for the course suggests that when a student has passed the Chalmers project course she/he should be able to:

- Identify, formulate and delimit a problem or task statement within the field of study.
- Plan the work to solve and report on the problem/task within a given time frame.
- Seek for, gather and critically interpret relevant literature and background information that is relevant to a problem-
- Integrate and develop knowledge relevant to solve the problem, and use that knowledge to solve the problem.
- Contribute to a project team that solves a complex problem.
- Engage in teamwork and cooperation in a project group.
- Use a diary to document the whole project process.
- Orally present and defend the problem solution.
- Document the result in a written report of good scientific quality.
- Evaluate the project outcomes with respect to the project's goals.
- Critically read and evaluate another project work with respect to problem formulation, project execution and results.

Course timeline

The work with the course starts in October, when the departments are invited to submit project proposals. Confer the course timeline (figure 1). The programme chairs then review the proposals in order to ensure their quality and relevance for their particular programme. The programme chair then decides which of the proposals that are eligible for selection by the programme students. The proposals are then posted on the course website. Students select and prioritize projects. They are then assigned to a particular project and project group. The outcome of the project selection phase is announced in early December.

The project work starts in the middle of January. A major first milestone is the planning report, as discussed below. At half time in the project course, in the beginning of April, the supervisor arranges a meeting together with the project group. At this meeting the students should give a status report and the supervisor will give feedback to the students concerning if the project meets the requirements for passing the course. The final presentation takes place in early June.

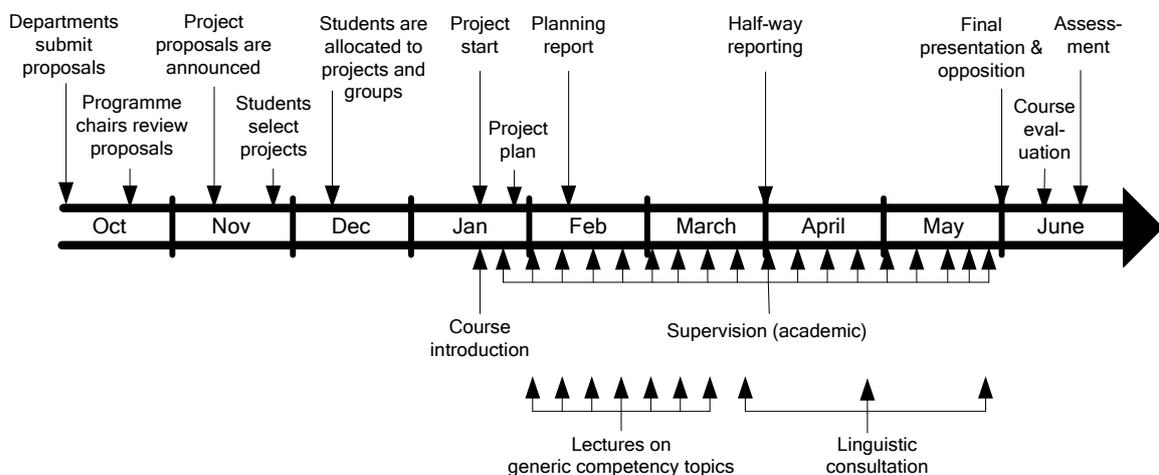


Figure 1: Course timeline.

Project examples

Examples of projects and their proposing departments include:

- Function and state assessment of building designs (Civil and Environmental Engineering)
- Autonomous model aircraft (Computer Science and Engineering)
- Electric bicycle (Energy and Environment)
- Prototypes for future detector systems (Fundamental Physics)
- Sucralose and DNA (Chemical and Biological Engineering)
- Bio-MEMS: Future medical instruments? (Microtechnology and Nanoscience)
- Shaping of wood (Materials and Manufacturing Technology)
- Stochastic modelling of economical time series (Mathematical Sciences)
- Lean family car (Product and Production Development)
- Ozone layer model (Radio and Space Sciences)
- New ferry concept (Shipping and Marine Technology)
- Automated music recognition (Signals and Systems)
- Change management strategies when introducing new working methods in children's hospital emergency unit (Technology Management and Economics)
- Vigor Wave Energy Converter (Applied Physics)
- Composite aircraft landing gear (Applied Mechanics)
- Lithographic thermometer (Student proposal)

The wide range of programmes that offer the course is clearly reflected in the different characters of the projects, even in this limited sample of projects. Many can be described as system design projects (Electric bicycle, Lean family car, New ferry concept), but there are also economic simulation projects (Stochastic modelling of economical time series) and organizational change projects (Change management strategies when introducing new working methods in children's hospital emergency unit).

Teaching and learning experiences

The teaching in the course includes lectures and practical exercises that train generic competence skills, as well as tutoring sessions for subject matter and linguistic consultation.

As indicated in figure 1, the teaching experiences aimed at giving the students the necessary generic competencies - project working competencies, information literacy and communication skills - to carry out the project, are run early in the term. These include lectures, practical sessions and workshops.

Tutoring sessions are arranged throughout the term: The supervisor arranges a start-up meeting with their project groups. The supervisor and the students discuss the project idea, about how the supervision will be carried out and how the presentation and opposition should be done. They also discuss the assessment of the project. The supervisor also introduces at start a "contract" between the project group's members – 3-6 students in each project group - in which the students are encouraged to decide how to work together in the group. They should decide about rules for the group when working with the project and they should document it and show it to the supervisor. The students are also encouraged to tell each other in the group what ambitions they have when carrying out the project course. This part is not shown to the supervisor but is an internal agreement in the group. The supervisor should tell the group about the extent of the supervision and make agreements of when to

meet with the group. Most of the supervisors meet their group once a week or even more frequently.

The students are also offered three linguistic consultation sessions. In these sessions, their emerging reports are reviewed and discussed by staff from Chalmers centre for Language and Communication.

Written reporting

During the project, the students document their work in a project plan, a planning report, a final report, and as continuous reporting. They also write an opposition report that analyzes and criticizes another group's final report.

Project plan. Initially in the project, the students should write a project plan containing

- A description of the aim, goals and scope of the project,
- Resource needs in the project
- The project time schedule
- Distribution of roles and responsibilities in the project

Planning report. However, the first major milestone in hand-in of a planning report in the middle of February. This planning report expands the project plan into a more detailed problem description and analysis. The programme chair decides about the method and time to hand-in the report. The planning report should contain the following headlines and information:

- Title
- Background
- Aim(s)
- Problem/issue/subject
- Limitations
- Method(s)/performance

Final report. The final report should be delivered in the end of May. The suggested disposition is:

- Title page
- Abstract/summary
- Table of contents
- Introduction/background
- Project description - main part
- Discussion
- Conclusions
- References
- Attachments

The design of the final report can differ depending on the character of the project chosen. A literature study has for example not the same disposition as design-build-test project. As a help the students are offered special writing instructions. Plagiarism is of course not accepted and all sources and references should be given in a correct way.

Continuous (individual) reporting. The first three reports are written by the project group in collaboration. In order to support the students' reflection on the project progress and to enable assessment of the individual contribution to the project result, they are also required to continuously document their work efforts. This continuous reporting consists of a time log that should be updated daily during the project work, and a diary that should be written at least once a week. In the diary the students should, in chronological order, describe the different project working phases. It should describe who did what, it should contain discussions and reflections on solutions chosen and it is recommended that it also tells about meetings in the group, planning, milestones etc. The supervisor should have the possibility to read in the diary and the time log before the meetings between the group and the supervisor.

A summary report of individual contributions from each project participant should be added to the final report. The report should tell account for distribution of roles and responsibilities in the project, including contributions to:

- Planning
- Information/literature search and analysis of collected information
- Selection of methods of research/development
- Problem solving, analysis and synthesis including contributions like creativity, active contribution in reflecting, project discussions and conclusions
- Main author of certain parts of the project report

Oral project presentations

Project presentations

Oral project presentations are carried out in beginning of June. Examiner, supervisor and opponents should be present at the presentations and oppositions. It is also recommended that the supervisor of the opposition group is present. The presentations are limited to 30 minutes including presentation, opposition and questions from examiner. At the oral presentations the following parameters are evaluated:

- Content
- Structure
- Presentation techniques/skills
- Visualization
- Time management
- Handling of questions

The content is judged from the point of view if the project participants have made a good choice of material from the final report for the presentation and if the material presented is adjusted to the audience and to the specific presentation situation. The structure is judged from the point of view if the presentation is well structured and easy to follow. All speakers should introduce and keep good (eye) contact with the audience during the presentation and should speak freely with only some support for the memory. Material used for visualization at the presentation (graphics, images, text etc) should be clear and easy to understand, and not contain too much detailed information. The speakers should tell about the material in a clear and comprehensible way. The project group should keep to the time offered (30 minutes). Questions from the audience ought to be handled and answered in a good way.

Opposition

After the project group's presentation there is an opposition. The opposition aims to clarify and question the content in the report. The opponent group has 10 minutes to present their discussion of the examined report.

The opposition group should also hand-in a written opposition report (400-600 words). In addition, each student should write an individual opposition report. The written opposition report should examine the report looking for strengths as well as weaknesses. It should illuminate and discuss the content. The following parameters should be judged:

- The structure of the report and other formal aspects
- Problem formulation
- Theory background and literature assessment
- Method/realization of the project
- Results, reflections, discussion, conclusions

The assessment of the opposition includes both the written and oral contributions from the group giving the opposition. A well performed opposition is characterized by relevant questions and ability to create context to the audience. The opposition should start and end in a planned way. Only constructive criticism is accepted.

Assessment

The assessment in the Chalmers project course involves several steps. The assessment concerning the result from the project group work is based on the following components:

- Planning report
- Final report
- Result from the project work
- Project working process

A 10-level scale is used to assess the different components. Each component is also assigned a weighting of importance on a scale 1-5. The highest score that a group can get is 100. The points allocated to each project group are then converted to a grade on the scale fail, 3, 4 or 5. 40 points or more are required to pass, 40-59 points yields the grade 3, 60-79 a grade 4, 80 or more a grade 5. The decision to initially judge each course element with respect to a 1-10 scale was taken in order to get a less rough and more flexible scale, when adding the points for all components to get the total sum. The components and weightings are summarized in table 1.

The final report is assessed with respect to a common set of criteria developed by Chalmers Centre for Communication and Languages. These so-called HISS criteria consider the holistic appearance of the report, contents and understanding, structure and language. These criteria are in turn sub-divided into sub-criteria that are connected to characterizations describing reports on various grade levels. The results from the project work (a "design", "simulation results" etc) are assessed in a subject-dependent fashion. The diaries and time logs are used along with the supervisor's impressions of his/her contacts with the group, to inform the assessment of project working process.

To be able to give individual grades basic data and methods to judge each students' contribution to the different parts of the project and to the result are needed. The grade of the project group is the baseline grade for the individual grade.

Table 1: Project group grade components and weights

Component	Assessment basis	Grade scale	Weight	Assessor
Planning report	Planning report instructions	0-10	1	Examiner
Final report	HISS criteria	0-10	5	Examiner
Result	Subject-dependent	0-10	2	Examiner
Project working process	Project diary Time log Supervisor's contact with group	0-10	2	Supervisor

A student's individual grade may, however, be raised as well as lowered from that baseline. The diary, time log and summary report are the formal bases for the individual assessment. Contacts and meetings between the supervisor and the students during the project process are also very important in this process. The individual student's contribution to the project presentation and opposition is also considered. The supervisors also have the possibility to utilize peer assessment, specifically to let the members in each group assess each others contribution to the project group result.

An individual student who is assessed to not have contributed sufficiently may be failed on the course. Students that do not pass have to re-do the entire course the following year.

The supervisor should at meeting tell the project group the basic assessment of their work and give each student a written evaluation of her/his contribution to the project. The examiner should also offer each student a discussion about the individual grading.

EVALUATION OF THE PROJECT COURSE

The project course has been carefully evaluated during its first two years. Below, we account for the methodology used to evaluate the course and the main findings.

Evaluation method and process

The main aims have been to evaluate the experience from running the course focusing on challenges deriving from the scale of the course, and from the team-based assessment. The evaluation has collected information from all categories involved in the course. Interviews and have been carried out with programme chairs, examiners, supervisors, administrative staff, librarians and staff at the language department. In addition, students have been interviewed and course evaluations from all programmes have been examined.

The course evaluation the first year focused on:

- Quality of the final project reports in comparison with the learning outcomes formulated in the course plan.
- The "double" role of the projects as both an individual work and a teamwork in the project group
- Grading
- Generic competencies
- Information given to the different actors involved
- The involved actors roles and responsibilities
- Planning and administration

The course evaluation the second year focused on:

- Information given to all actors before and during the course
- The course memo with its course information to students
- Allocation of different tasks to involved actors in the course
- The connection between the learning outcomes stated in the course plan and the course elements
- Assessment instructions and criteria
- The “double” role of the projects as both an individual work and a teamwork in the project group – how can the individual contribution from each student be judged in a fair way

Interviews with the actors

Supervisors

Generally the supervisors were very positive to the role of being supervisors in the course. They seemed to really appreciate the students' way of working. The students were described as very interested, responsible, mature, skilled in cooperating and reflecting on their projects, and capable of giving constructive criticism to other project groups. Most supervisors were of the opinion that the generic competencies learning experiences have been a good help to the students. The planning report, time log and diary used to follow the project work were regarded as helpful tools to monitor the project progress.

The positive impression can also be seen in the assessment and grading of the students' project work. Most of the project groups got the highest (5) or the second highest (4) grade. In most cases all students in the same project group got the same grade.

On questions regarding the course learning outcomes and if they are met most of the supervisors considered them as fulfilled. Regarding the students writing skills, most supervisors regarded as them as acceptable. The supervisors also described the students' oral presentations and oppositions as well performed. However, they also reported that they think that the course goals are not very obvious to the students. The supervisors maintained that the intended learning outcomes are too numerous and not easy to keep in mind.

Many of the supervisors found it difficult to distinguish between the individuals in a project group. Several supervisors expressed wishes for more clear assessment criteria, for the whole group as well as for the individual students. Several supervisors asked the question if it is meaningful at all to try to distinguish between the students in a group – the Chalmers project course should offer training and practice in how to cooperate in a real way close to reality. In society, in the reality, it is the result of the group that is interesting, not the contribution from each individual. It should therefore be the result from the whole project group that is assessed. Some supervisors further argued that the individual grading adds an unnecessary element of worry which is not in agreement with the course's aims of learning to work together effectively in a group. However, the job split between the supervisors as the main teachers in the course and the examiners as assessors is reported to have functioned very well, with few conflicts regarding assessment and grades given to the project groups and the individuals.

When we asked about the amount of time (hours) spent on supervising the project groups the answers were vague from the supervisors – almost none keep record on how much time that was spent on supervising. However, many teachers stated that the supervision was more time demanding than expected and that they were not allocated a sufficient amount of hours for this task before the start of the projects.

While most of the supervisors met their group once a week some meet the students even more frequently – especially projects with laboratory elements in close proximity to the supervisor's office. In these cases, the supervisor sometimes experienced the frequent questions and interruptions as disturbing and stressing.

When the supervisors were asked if they needed any additional support in their role as supervisors the answer was no and they did not wish for any particular type of support. Many of the supervisors stated that they have had the opportunity to talk to and get advice from other supervisors/colleagues at their own department and that this is satisfactory. In some cases, there has also been a second supervisor present – for example a doctoral student.

Concerning information given before and during the course also the supervisors asked for better information published in a common webpage giving a clear overview of all course activities and clarifying roles and responsibilities in the course.

Language department and library staff

Also the teachers/supervisor/librarians at the language department and Chalmers library were very positive to the students' projects. Most of the students were described as very active and interested and capable of working effectively together in groups and writing good project reports. However, these actors also argue that the students could gain a lot by learning more/get more skilled concerning the generic competencies and information literacy. The language department staff and the library staff both wished for a closer contact with the supervisors.

The project group size has varied. The recommended group size is 4-6 participants. However there are also smaller groups with only 2-3 participants. This has normally not been seen as a problem from the supervisors' point of view but the teachers/staff at the library and language department regarded this as a problem because it demands more resources and takes more time. A comment is also that the group-dynamic experience disappears if the groups have few participants.

Concerning information before and during the course also the language department staff and the librarians expressed wishes for a webpage with information that is easy to grasp for all actors involved in the course. There was also a wish for a better notification system connected to the schedule system so that changes to the schedule for generic competency learning experiences can be easily visible and transparent to everyone. Documentation of the compulsory course elements was also problematic to some degree. It is a time consuming job to sign all the students' attendance cards.

Administrative staff

The administrative staff has very important and comprehensive tasks before and during the Chalmers project course. Also the administrative staff reported information problems and wishes to have one webpage where all course information can be published and accessed. The administrative staff also requested a clearer overview of who does what and when.

Students

The data from course evaluations showed that the course is appreciated by a large majority of students as a very engaging and interesting course although the students also indicated that the course demands a lot of work. Almost all students were very positive to the project group work, and to learn about and practice group dynamics.

The course evaluations from the first year (2007), showed rather heavy criticism regarding the information in the course. Students at all programs were very critical to how and where

the information was given before and during the course. The information was reported to be unclear, sometimes wrong, given too late and was changed during the course. This situation caused confusion and extra work. But there were also several innovative suggestions on how to make the information situation better: The students asked very clearly for **one common** webpage giving all necessary information in a clear way concerning the whole course. They also asked for a possibility to carry out the project selection on the web to facilitate the process for both students and staff thus saving a lot of time. It was not only the students but also the staff that asked for better information before and during the course. Sometimes the staff could not give correct information and answer the students' questions and this was obviously frustrating and led to some criticism.

The course evaluations have also shown that about half of the students are satisfied with the assessment and the individual grading, and the other half is not. It should also be noted that the encouragement to the students to write a mutual contract/agreement in the beginning of the project telling of their individual ambitions does actually not seem to have a function to fill. The fact is that almost all students decide for the ambition on the highest level – they want the highest grade.

Discussion

The students have a very positive attitude regarding the project course. Also the supervisors/teachers are very satisfied with the quality and conduct of the students' project work.

The setup of the development process and team proved to be very effective in terms of creating the new course design. The programme chairs that constituted the development team also had the authority to make decisions about the intended learning outcomes, the assessment scheme etc. In Kotter's terms, they had established a sense of urgency, had a common vision, and formed a powerful guiding coalition [12] that was able to overcome Chalmers' tradition of "silo-style" programme development, and instead, work out a common solution. However, administrative staff was poorly represented on the development team. This omission may partly have caused the information flow issues discussed below.

The major difficulty in running such a large-scale project course have thus been the problems connected to obtaining a clear and consistent information flow to students and staff, along with an clarification of each actors roles and responsibilities. The first year evaluation, in 2007, manifested an obvious need for a coordinating person taking responsibility for all common information activities and tasks concerning the Chalmers project course. This was acutely arranged by engaging a person for these tasks for a period of 3 months in autumn 2007 before the start of the 2008 project course. The coordinator concentrated his work on planning a process for giving clear and consistent information to all actors involved in the project course. A communication plan for the course was also presented pointing out what should happen and when before and during the course. There were also efforts to show and decide about different roles and tasks for the actors involved.

Also in the course evaluations from the second-year course, 2008, it was still the information flow that rendered most disappointment, although the criticism is somewhat milder, probably due to the improvements that had been made. There has been a large effort, involving many persons, to improve the administrative aspects of the course during its first two years. The information has gradually become better and the project selection can now be carried out on the web, which is highly appreciated by the students.

The generic competencies learning experiences are taught by staff at the language department and the library. The various educational programmes at Chalmers do not offer the students generic competencies during the students first to years in the same way. The

result of this is that the students' skills concerning generic competencies and information literacy differs when they reach the third year. From a project work point of view, this is not regarded as a problem since the students work together in groups and can help each other, can learn from each other, and can supplement each others knowledge and skills. Lectures in certain generic competencies were compulsory the first year. However this resulted in some criticism, due to the varying background of the students. Because of this, the lectures are no longer compulsory. However, the supervising meetings at the language department are still compulsory and are appreciated by the students. The project groups do themselves book the meetings when they feel it is suitable in time. There are suggestions to further investigate the role of the generic competencies learning experiences and how these experiences are connected to the subject part in the projects. It is also suggested to investigate which generic competencies the students are offered at the various educational programmes during their first two years in order to get an overview of their skills they are expected to have when starting the Chalmers project course. There is also a need for an even clearer explanation of the importance of the aims and importance of the generic competencies in connection with the project work.

The assessment in the Chalmers project course involves multiple steps and components. When looking at the statistics (for both the first and the second year the course was given) concerning the grades, both for the group and the individual participants, we find that most projects and students have got a high mark 4 or 5 (on a scale of 5) so the differentiation is small. It has been discussed if this is a problem or not. Maybe it is very natural because the students have high ambitions and state these before the course starts. The observation of the small grade variation is also in agreement with the difficulties reported from the supervisors on giving individual grades in the project group work. However, there are also some significant differences in the average grades awarded by different departments, which might imply that they are interpreting and applying the assessment scale differently. It may also be caused by variation in quality of students and their project work. It is apparent from the evaluation of the course that the assessment criteria, and how they are practiced by examiner and supervisors, need further discussion.

CONCLUSIONS

The start of the large-scale project course at Chalmers shows that it is possible to run such a large project course with positive results: The teachers are very satisfied with the quality of the students project work, as well as by the process skills that the students demonstrate. The course is a very popular course among students.

The design of such a course poses course design challenges related to agreement on intended learning outcomes and assessment, handling of varying pre-generic competence skills and project group selection. A development team composed of the programme chairs for each program was effective in resolving these issues in a timely manner.

The large scale poses communication challenges: There have been problems with obtaining a clear, complete and consistent information flow to students and staff and there have been problems to get all involved to understand all other roles and responsibilities. To address these issues, a university-wide coordination function has been developed to organise and follow this project course during the coming years.

Assessment and grading is a challenge in project courses which is even more emphasized in the large scale. The assessment is inherently complex with many factors to consider, and many teachers perform the assessment. There have been some signs of systematic grade differences between departments, which may be considered by students as unfair. There is a need for continued evaluation and refinement of the assessment scheme.

REFERENCES

- [1] Leifer, L., "Evaluating Product-Based-Learning Education", Proceedings of the International Workshop on the Evaluation on Engineering Education, Osaka, Japan, 1995.
- [2] Aalborg University, Work Methods at AAU, <http://studyguide.aau.dk/workmethod>, accessed on April 8, 2009.
- [3] Crawley, E. F., Malmqvist, J., Brodeur, D. R., Östlund, S. Rethinking Engineering Education – The CDIO Approach, Springer-Verlag, New York, 2007.
- [4] Svensson, T., Krysander, C., The LIPS Project Model, Technical Report, Linköping University, Linköping, Sweden, 2004.
- [5] Zavbi, R., Tavcar, J., Verlinden, J., "Educating Future Product Developers in Virtual Collaboration: Five Years of the E-GPR Course", In Higher Creativity for Virtual Teams: Developing Platforms for Co-creation, Hershey, PA, USA, 2007, pp 48-74.
- [6] Edström, K., El Gaidi, K., Hallström, S., Kutteneuler, J., "Integrated Assessment of Disciplinary, Personal and Interpersonal skills - Student Perceptions of a Novel Learning Experience", Proceeding of the 13th Conference on Improving Student Learning, London, UK, 2005.
- [7] Schneider B., McDonald S.-K., Scale-up in education. Volume 1: Ideas in principle, Rowman & Littlefield Publishers Inc., 2007.
- [8] Malmqvist, J. Young, P. W., Hallström, S., Kutteneuler, J., Svensson, T. Lessons Learned from Design-build-test-based Project Courses. Proceedings of Design-2004, Dubrovnik, Croatia, 2004, pp 665-672.
- [9] Kovacevic, A., "Competence Development on an International Product Design Course", Proceedings Design 2008, Dubrovnik, Croatia, 2008, pp 1383-1392.
- [10] Ministry of Education and Research. Higher Education Ordinance, SFS 1993:100, with amendments up to SFS 2006:1054, Stockholm, Sweden, 2006.
- [11] Chalmers University of Technology, Bachelor Thesis Web page, http://www.chalmers.se/sections/ar_student/kandidatarbete, accessed on April 8, 2009. (In Swedish.)
- [12] Kotter, J. P. "Leading Change: Why Transformation Efforts Fail", Harvard Business Review, 1995, pp 59-67.

Biographical Information

Elisabeth Saalman, PhD, is a teacher, researcher and project leader at the IT University, Chalmers University of Technology, Göteborg, Sweden. Her scholarly interests and research focuses on educational development and creation of good learning environments with the use of good learning resources. She has a big interest in virtual communication and its possibilities in education, for learning in digital media but also for project work and e-meetings. She has been the project leader for the evaluation process of the Chalmers project course during its first two years.

Lena Peterson is an associate professor in Electronic Design and Dean of Education at Chalmers University of Technology. Her research interests are design methodologies for analog circuits and mixed-mode electronics systems and the learning and understanding of such methodologies.

Johan Malmqvist is a professor in Product Development and Dean of Education at Chalmers University of Technology, Göteborg, Sweden. His current research focuses on information management in the product development process (PLM) and on curriculum development methodology.

Corresponding author

Dr Elisabeth Saalman
Chalmers University of Technology
Department of Applied Information Technology
SE-412 96 Göteborg, SWEDEN

Phone: +46 31 772 8579
E-mail: Elisabeth.saalman@chalmers.se