

Creation of a Collaborative Study Community in Engineering Studies

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Abstract

This paper describes a novel course structure in the beginning of engineering studies. The aim of the course was to integrate new students into the study community by keeping them tightly together in one classroom during the first eight weeks of study. The idea was based on project based learning that had already been introduced in many universities. However, the course did not revolve around one single project, but consisted of several small team assignments. The paper is a case study that describes the course and its findings, comparing the situation with previous years' experiences that have been documented in several earlier studies. Feedback and notes were collected regularly during the course. Student surveys after the course indicated a high student satisfaction.

Keywords: *Engineering education, Collaborative practices, Networked expertise, Project based learning*

1. Introduction

Traditional tightly subject-oriented pedagogical approach seems to approach the end of its lifetime. The work-life practises have changed from individual effort to collaborative and team work tasks. This change is reflected in requirements set for university studies where the engineering profession is defined by competences [1][2]. However, institutions in higher education have largely continued to follow content based curricula where the topics are studied separately in separate courses.

Dropout rates for engineering degree programmes in Finland have been high for the last 15 years, which has led to a search for more attractive educational methods. Many engineering education institutions have sought to introduce engineering practices through project-based learning into the curriculum. The global CDIO initiative has gathered a number of institutions around a common curriculum structure, including several Finnish universities [3]. On the other hand, project-based learning has been applied by Aalborg University as well as many others [4]. CDIO projects and elements have been included in our curricula, as well, since 2009 [5]. The need to introduce more multidisciplinary projects has been acknowledged, and the Metropolia Minno scheme has been developed as a framework for third year innovation projects where students of different disciplines design solutions for real business problems.

Collaborative problem solving and project based learning have been considered as central methods to educate present day engineering students, because they simulate challenges that the students will face in the professional work, such as open ended assignments, uncertainty and coordination of collaborative efforts [6]. Numerous implementations of project based learning methods have been reported in various countries in recent years. [7-9]

Gokhale found that collaborative learning environment provided students with opportunities to analyse, synthesise and evaluate ideas cooperatively, and informal discussions and interactions helped students to understand and share knowledge and experience, get helpful feedback and learn critical thinking [9]. Kreins, Kircher and Jochems noted that social interactions are the key to an efficient collaborative learning and lack of the interactions can prevent collaborative learning [11].

Muukkonen and Lakkala studied an undergraduate university course where the students were exposed to dealing with open-ended collaborative inquiry. They concluded that dealing with uncertainty and areas beyond ones' expertise and engagement in self-directed collaborative work are decisive experiences for developing the needed

skills in knowledge work [12]. Moreover, Meier, Spada and Rummel identified five empirically induced aspects for successful collaborative process: communication, joint information processing, coordination, interpersonal relationship, and motivation [13].

1.1. Aims of the study

Despite of various efforts to introduce projects into the curriculum, the main study mode in Metropolia was based on lectures and laboratory exercises until August 2014 when a new university-wide curriculum was introduced. The curriculum reform was based on principles of learning as knowledge inquiry and collaboration across disciplines and together with enterprises and community [14][15][16]. The head of the international Information Technology programme seized the opportunity to fully change the modes of study, and decided to start the studies with an Orientation course that consisted of various elements that introduced students to the university studies, projects and teamwork practices.

The aim of this study is to examine how the planning and implementation of the Orientation course took place, and how well it succeeded in creating a collaborative study community. Educational methods are described, as well as the elements and tasks in the course. The findings discuss how the participating students and teachers experienced the course practices, and how they described the benefits and challenges.

2. Materials and Methods

This paper describes a case study of collaborative repeated practices in one course unit. All exercises in the course contributed to collaborative and repetitive practices. Students completed some individual tasks such as setting up their PCs, installation of home pages and photo-editing, but most assignments were worked in teams. The team set-up changed between assignments, but mainly three to four students worked together.

A particular feature of the course was relative lack of material produced by teachers. Lectures were kept short, and the main aim of the lectures were to introduce a new task. Instructions were as short as possible, and students were encouraged to ask for help and help each other as much as possible. In fact, students produced some of their learning materials in teams. Nevertheless, students were not left alone with hard problems, but one or two of the teachers were always available for instruction.

2.1 Setting and participants

Planning of the course was started during the previous semester in spring 2014. A team of teachers were invited by the head of IT degree programme to plan together an introductory course for the new first year curriculum. The aim of the new curriculum was to integrate smaller courses into larger ones and renew the pedagogical models and habits used in our university. The head's personal aim was that the IT degree programme could be in the frontier of the pedagogical reform.

The team of teachers gathered together totally seven times between March and June 2014. Weekly course schedules were fixed together and proposed for the schedule planner. Discussion about the aimed project for IT orientation course lead to an idea of dividing the task into smaller parts and having weekly themes. Teachers' notes and comments were collected into the school's intranet tool and analysed later.

The new pedagogical approach suggested also changes in the facilities. A proposal for investment for new furniture and other facilities was developed. Discussion about the suitable IT tools and environment and evaluation and grading criteria continued until the beginning of the course.

Mathematics and basics of Finnish language were taught separately, but English communication skills were partially integrated to the project work. The practical application of the language and communication skills were linked to the project works and the evaluation of those skills were partly done together with the project teachers in presentation situations. The orientation course aimed at giving students a good understanding of information technology basics, as well as enhancing independent learning skills and adopting academic practices. At the same time, students learned teamwork and project management when completing course assignments.

The student group consisted of 48 engineering students with a diverse nationality background, majority being young male Asians from Vietnam and Nepal who arrived to Finland just when the semester began. They were divided into two study groups, which both had five teachers from different professional disciplines such as mathematics, software and media engineering, and communication skills. Even though students mainly came from high school background, several also had previous university studies in their own country.

The classroom furniture was arranged in groups of small tables that could flexibly be rearranged for teamwork or lectures. Moreover, there were movable white boards, six fixed PC work stations and a teacher's desk with a PC and projector connection. However, the facilities were not in place when the semester started. In fact, students had to assist in setting up and furnishing the classrooms. This was not intended beforehand but a reality that the staff and students faced because of administrative delays. The situation caused some stress to the staff members; however, students rather took it in a positive way. The first study week has always been somewhat disorganized, even in earlier years, because many foreign students arrive late to the country due to visa processes, and courses cannot start in full when many are missing.

2.2. The course outline

The course was implemented on the first 8 week period of autumn semester 2014. The course outline was arranged around weekly themes, each having technical, social, epistemological and cognitive goals.

Before the beginning of the course the new students had an orientation week, when they received basic information about studying in Finland and in our university, and received the keys to the classrooms and access to the IT systems. The very first task was to design and implement in small teams an egg dropping device that was immediately tested. The only given instruction was that the egg should land safely and sound to the ground. The aim of this task was to work as an ice-breaker and help the students get to know each other. The experiments were video-recorded and shared to all by a teacher.

The first week's theme was built around of knowing each other. The two study groups were instructed slightly differently. In group A the students were asked to work in small teams and make a team presentation on topic "who we are" in English using digital tools, as in group B the students were asked to make personal presentations on "who am I" in Finnish language and using paper only. The same theme was also used in Finnish language classes. The teams and students presented their posters and presentations at the end of the week. Moreover, cross-group interaction took place when international students presented their group to a Finnish group of first-year students, and the Finnish students showed their game project designs to the international group. Consequently, both groups went together to a student association event during the weekend.

The second week's theme was to know the university's facilities. The technical goal was to learn documentation skills and to become familiar with Metropolia's IT systems, as the social aim was to practice teamwork skills. The systems and facilities were divided within the small teams and each team's task was to find out and document the selected system, facility or service. The material was collected to a shared wiki-page into Metropolia's IT systems, and presented to other teams. One day was spent in installing Linux on student laptops, which they had for their personal use for the first study year. Additionally, an unscheduled social event was the freshman party which was organized at the end of the week to celebrate the finishing of the classrooms' furnishings.

Weeks 3 to 6 were arranged in different order between the groups due to scheduling issues, but the contents were same.

The third theme was a five day crash course on assembling a PC, aiming to give students a real hands-on experience about how to survive with PCs and operating systems. Another goal was to teach students to work in teams. The first day contained lectures of the PC's history and discussions on what should be considered before buying a new computer. The homework was to simulate how and what to buy in case the students should build a computer for their own family member. Learning was based on listening and learning from expert stories. On the second day the students assembled desktop computers from parts. Teams were built around students who had experience on the building process beforehand; their task was to minimise damages to components. The teams installed the most current operating system (MS Windows 8.1) and the whole class discussed on how to benefit from the knowledge they learn during this course, emphasizing to value their own earned knowledge as they will certainly need to support their relatives and neighbours when they return from the school back home. During the following days, the students met real computer viruses, learned about the Internet, built a network by themselves with wireless routers and learned to look under the hood of an operating system. A small competitive task was given at the end of the week. The winner was the team that could first remotely start Notepad on another teams' computer.

Weeks 4 to 6 tasks were around basics of photography, photo editing, creating group portfolios and web-pages. The aims were to learn basics of portrait photography, the properties and formats of digital images, digital image editing, and basics of HTML and CSS coding. Each student visited a photography studio and practiced taking portrait photographs in small teams and used the material to create their own web-page portfolios. All learning

and processing took place in small teams within the group. Team work methods and best practices were introduced parallel to these work exercises.

Weeks 7 and 8 were reserved for feedback, final evaluation and supplementary work. The students were guided to complete all unfinished assignments and feedback was given before the final evaluation. Separate examinations were arranged on mathematics and Finnish language. In English communication the final homework was to find a job advertisement in the field of IT that they could consider applying for and write a CV and cover letter for that. In addition, the English communication teacher participated and evaluated the presentations the students gave in their project works. The final evaluation was made together with all teachers involved in teaching and the final grade was discussed before it was revealed to the student. The last week was reserved for supplementary assignments in order to get late arrived students on the same line with the rest of the class.

2.3 Data collection and analysis

The case study relies on planning notes, teacher observations, materials created by the students, feedback collected during and after the course, and course results. The observations of classroom practices were recorded to field notes by one teacher of the course. Teacher observations and produced materials were used to descriptively evaluate the course practices.

Students' and teachers' opinions and experiences on the course were collected through an online questionnaire after the course. The following student questions were used as data: How would you characterize your overall experience in the course? What has been positive or impressive in the course? What has been challenging or disturbing in the course? Teachers answered to the following questions after the course: What succeeded well in the course? What did not succeed well? How were the goals of the course achieved? What would you do differently if the course were implemented again? In all, 32 students and five teachers answered to the questionnaire. The written answers were analysed in order to unfold the students' and teachers' experiences and opinions of the course practices and the teachers' evaluation of collegial collaboration in planning and implementing the course. Descriptive summaries of the answers were constructed in a data-driven manner.

Even though the course included wide variety of subjects, a single grade was given for the whole course. Basis for student grading was numerical evaluation of each of the separate tasks on scale 0 to 5. In evaluation for one of the tasks, university's facilities documentation in wiki pages, also peer evaluations were collected and used. Finally, task evaluations and mathematics and Finnish language grades were weighted by their relative work amount in calculating the grade for the whole course.

3. Findings

3.1 Observations

The first assignment was a team presentation "who we are?" that was done to make students familiar with each other and their backgrounds. One group completed this as a poster, the other group created a PowerPoint presentation. The other larger task was to create wiki-pages that explained the learning environment in the campus including sports and library services as well as the intranet and IT services. The students wrote a description of themselves also in the Finnish language that they had just started to learn. Embedding language studies to other professional activities motivated students in their language studies, which they completed better than in earlier years. Moreover, collaboration between subjects encouraged students to complete tasks on time, not to mention effects of peer pressure in the delivery of assignments.

Story-telling and dialogue in the classroom about real incidents related to computer installations made an amusing episode that the students remembered well. It also triggered a lively discussion where students could learn from their classmates experiences and knowledge. Going over team borders turned out to be rewarding. Team work across teams was the real highlight of creating collaboration. Teams had mostly worked as separate groups only concentrating to internal communication but eventually they created a network where the computers communicated over the team borders.

A major, and rather surprising finding of the course was the fast speed of adopting basic teamwork practices even though most of the students had never before been allowed to work in teams. Probably a tight study group

helped immigrant students adapt to the new country and study environment, as well, and made them feel more confident and secure in the new environment.

Another important finding was the high degree of independence that the student group acquired within a few weeks. One of the first tasks was to setup a personal laptop by installing Ubuntu Linux, browsers, and office software on it. This task was completed within a few hours, remarkably with little teacher intervention, as more experienced students took charge of assisting less experienced users. That pattern was adopted as a permanent study mode, and it gave a good lesson for instructors, as well. The teachers had to acknowledge that students have previous knowledge and skills that they were able to use creatively when assignments were structured in an open way.

3.2 Students' evaluation of the course

Concerning the overall experience in the course, totally 21 positive statements were found from the students' feedbacks started from "more familiar with the study environment", "managing timetables effectively", "interesting and practical" and ending to the praise like "great", "fantastic", "wonderful" or "the best orientation course I have ever had".

Four of the students experienced the course neutrally commenting it to be satisfied, quite satisfied, or what I expected, and only one complained that he/she did not learn very much or the course was trivial.

To the question about positive or impressive aspects in the course, the most mentioned aspects were interactions, receiving and giving feedback (5), getting to know the classmates (6), teachers' help and guidance (6) and teamwork (5), as well as learning general knowledge and new technologies (5). Also the schedule or rhythm of studying (5) were appreciated. Some students also mentioned the overall arrangements (3), that everything was good (3) or the facilities (2).

Overall (3) the students liked the arrangement and thought that everything (3) was good. Also the facilities were mentioned twice.

To the question about challenging or disturbing issues, some students commented having no problems or wrote that everything is ok (4). Students also mentioned unclear course content or structure (3), unknown evaluation criteria (1) and lack of illustrations (1). Group work was mentioned once (1) and the group presentations given with somebody unfamiliar for the student (1). Languages, specially the Finnish language (3) were also mentioned. A couple of students complained that the exercises were trivial, or there were too few practice, or the materials or end products were not practicable. The schedule, early wakeup times and sleepiness each were mentioned once. Some notions about weak base of IT knowledge and difficulties or confusion with technical practices like CSS/HTML coding or using Ubuntu and GIMP were mentioned.

3.3. Teachers' evaluation of the collaborative planning and course practices

Teachers answered four different questions that are summarized here. To the question about what worked well in the course, the issues mentioned by several of the five teachers were teacher collaboration in integrating teaching (3), schedule and arrangements (3) and communication with students (3). Also active and motivated students (2), student learning (1) and teaching in general (1) were mentioned in the teachers' answers as positive issues.

Four teachers answered to the question about what did not work well in the course. Two teachers mentioned that the course had a tight timetable. One teacher complained about difficulties to find time for the teachers' joint meetings, and one teacher mentioned that not all subjects integrated naturally into the same entity. One teacher was dissatisfied with the classroom facilities. One teacher mentioned that transfer students who had already studied in some other program did not adopt new working methods very easily; they also simultaneously conducted second-year studies.

All five teachers evaluated that the goals of the course were achieved well. One teacher thought that the goals were exceeded because the competence level of the students was so high. One teacher mentioned that the students' motivation for learning increased from the beginning. One teacher remarked that even though the goals were met, more time should have been allocated to practicing the new ways of learning.

The teachers were also asked, what they would do differently in a new implementation of the course; four teachers answered to the question. One teacher would decrease the amount of content, and one would organize mathematics as a separate study unit. One teacher thought that not so many teachers need to be present in the

class at the same time. One teacher discussed about the role of the transfer students; there should be either first or second year students, and no other options should be offered.

3.4. Pass rate of the course

In total 48 students started the course and of those, 47, or 98% passed. This represents a very high pass rate, although exact comparison with earlier years is somewhat complicated because of different course structure.

4. Discussion and conclusions

Collaborative work towards a shared goal has proven to be an efficient and inspiring mode of study, and in this case, it was introduced immediately in the first course. The aim was to create a community of first-year students who would later support each other in their studies.

One of the main problems with international study groups has been the slow integration to the new university environment and adoption of proper study habits [17]. They have sought help from teachers and study advisors, requiring repeated instruction about the same issues. The orientation course enabled students to acquire basic knowledge of the study environment together, and after learning to know each other, they had a large pool of informants available. The course also helped students to make friends, because everyone was forced to work with others. The collaborative practices developed during this course could later be observed in following studies. Whether they persist till next study years is not yet proven.

Teams must be encouraged to work as a team by designing tasks that very clearly benefit from team activity. Encouragement for students to present their own opinions makes them see their capabilities, and their ability to help others in professional matters. Cross-team competition and mutual helping between teams simulates professional situations within companies or with clients.

In educational settings applying collaborative practices, students do not necessarily succeed very well in group work or progress expectedly in finalizing their products [18][19]. One reason is that students are left too much alone in managing the new ways of working; they have to learn the critical skills spontaneously or through trial and error. In the present case, through multiple successive group assignments the students got repeated opportunities to practice collaboration skills as well as get feedback from peers and guidance from teachers, which were mentioned by many students as central positive aspects of the course experience.

The findings are not surprising when compared with other results of project based learning [7][8]. However, the faculty in our university has been reluctant to apply collaborative methods due to the lack of convincing information. Therefore, close follow-up and continuing research of the development of student competences is still needed. Nevertheless, the most important goal from the university point of view was achieved: for the first time all but one student passed their first period courses.

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