Teaching working life skills in IT through collaborative practices

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INTRODUCTION

Current changes in software industry and software development methods call for appropriate teaching methods in the academia. In addition to the theoretical knowledge and coding ability, familiarity with common practices in the industry are expected from the graduates. Teamwork, collaboration and communication skills are essential demands for software engineers. These skills presumably take years to develop, and therefore, this study presents how collaborative practices have been introduced right in the beginning of engineering studies in IT.

This paper presents efforts through a curriculum reform aiming at teaching working life practices throughout studies. The reform was implemented in August 2014, and its effects have now been monitored until the end of the second year. The curriculum

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is based on project and team-work, as well as relatively small study groups.[1] The content of the curriculum remained largely the same in the reform but the order of subjects was shuffled in order to bring more professional content and collaboration to the beginning and spreading science and other basic studies more evenly through the years.

In this paper, we first discuss working life skills and how the demands in industry have recently changed. Next, we explain how the curriculum was designed to incorporate them, and various efforts to introduce new skills. Finally, we discuss the outcomes of these efforts.

1 WORKING LIFE SKILLS

1.1 Common understanding of working life skills

What are the demanded working life skills in engineering or IT? According to Marjoram, the engineering education has developed worldwide towards similar overall practices [3]. There is a wide consensus on main goals of engineering education. For example, the list of goals by ABET (formerly the Accreditation Board for Engineering and Technology) that accredits college and university programs in the disciplines of applied science, computing, engineering, and engineering technology at the associate, bachelor, and master degree levels in The United States has not changed in the last decade. [4] ABET includes in the student outcome requirements for any engineering program general science and technology skills, research skills for conducting and analysing experiments and data, and an ability to formulate engineering problems. Engineers need to be able to consider also constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability, and to act ethically. Particular working life skills are listed as an ability to function on multidisciplinary teams, and to communicate effectively.

The UNESCO report on engineering mentions similar capabilities, and refers to a many other organizations and accreditation bodies [3]. The question remains, however, how these goals are attained through education. One of the obvious solutions promoted by Kolmos et al [5] is the application of project and problem based learning.

1.2 Software industry requirements

Feedback from software industry indicates that graduates are not necessarily fully prepared for working life. To find out what might be the actual needs we conducted interviews in relevant industry. The outcome of these interviews and industry contacts confirmed some of the points mentioned, such as the ability to function on multidisciplinary teams and the ability to communicate effectively are needed, but also need of negotiation skills, and interestingly a need to understand development processes.[6]

Three alumni from our University of Applied Sciences were formally interviewed in August 2015 in order to get insight into what they felt was not included in the curriculum, but what they would have needed after graduation. Following points were brought up: 1) meetings and negotiations in small groups (five people or so), 2) presenting and justifying a technical solution to colleagues, 3) what kind of language should one use with customers and project communications with various project stakeholders, 4) as well as taking notes in meetings. Meetings and presentations in small teams was an interesting and new aspect. Until now the curriculum included a fair amount of presentations to the whole class, but very limited opportunities to exercise presentation and negotiation skills in small teams.

The actual needs by industry and the needs mentioned in the organizations' or accreditation bodies' requirements were combined when redesigning courses to have better match between the industry needs and keeping interest of the students. In the following chapter, we shall discuss the theoretical bases and the curriculum and module design. Then, the research process and outcomes will be presented and evaluated.

2 PEDAGOGICAL DESIGN

2.1 Theoretical bases

For integrating the different needs in a meaningful, interesting and pedagogically sound way, theoretical bases of collaborative study in higher education were applied. Trialogical learning theory that combines collective effort, progressive inquiry and use of technological artefacts in the study, gives fruitful insights for researching education in information technology. Trialogical learning underlines the learning where the industry needed skills are practices within other activities also. According to Paavola and Hakkarainen [7], learning is not only individual knowledge acquisition or adoption of existing social and professional practices, but also the creation of new knowledge and practices in collaboration with others. In these activities the students' deliberate engagement in producing something concrete and meaningful together fosters deep learning of professional practices.

2.2 Description of curriculum and module design

In the information technology degree programme, the studies were integrated into thematic 15 ECTS modules of eight study weeks each. All information technology students were first divided into groups of approximately 30 students who studied the first year together. In the second year, students started studying in majors such as software engineering, mobile solutions, games, and networks. The group size was more varied ranging between 15 to 45 students depending on the popularity of the major. However, each group studied together mainly in one "home" classroom throughout the period except for particular laboratory sessions in electronics, physics and networks. The modules and their implementation in 2014-15 have been discussed in more detail in [1], and [8].

The themes in the first year were called Orientation or Objects, Games, Robots and Networks, rotating through the study year. Each theme had an instructor team of 5 or 6 teachers who had a considerable degree of freedom when planning the implementation. Therefore, the ways that subjects were integrated varied widely. Some implementations actually consisted of quite separate parts, whereas others had a larger unified project assignment. Additionally, classroom arrangements were changed from previous years because of reduction of lecturing. New furniture, white boards, etc. were purchased. The furniture arrangements were flexible, allowing different sizes of grouping, and small tables and white boards could be moved around. There were some fixed computer workstations in addition to student laptops. The university had a limited number of cheap laptops available, however, many students opted for their own device in order to get better performance.

2.3 Inclusion of working life skills

In the second year, more professional content was added to the curriculum depending on the major that students chose. However, students continued to work with projects that resulted in a functional product according to the specifications given by instructors. Collaborative assignments were always combined with individual study that consisted of tasks such as programming assignments, virtual courses using MOOCs, and writing tasks. Language and communication studies were integrated into projects: students wrote project plans and reports and prepared presentations. They also practiced writing CVs and professional emails.

Nevertheless, the design of project modules turned out to be demanding because they had to fulfil a variety of goals at the same time:

- To introduce working life practices and skills such as project communication, teamwork, negotiations, project planning and monitoring, and documentation.
- To teach programming and other essential technologies.
- To understand the process of software development project and to implement it in practice.
- To reach a goal such as a functioning software application.
- To accumulate theoretical understanding in the respective field and to strengthen basics of natural sciences.

3 RESEARCH AND RESULTS

3.1 Methods

The broad aim of our research was to find out what are the current needs for students' working life competences in software industry. Our research questions asked "How can these be addressed in education" and "how did we succeeded in our recent efforts"? The particular competences that we aimed at were 1) teamwork and 2) professional communication within projects.

Student and teacher views were collected after each module using the CKP questionnaire that measures student evaluation of own learning of collaboration practices. The questionnaire was available online at the end of each module. The questionnaire was given to students and teachers in 39 modules of the new curriculum who started the study in the term 2014-15 or fall 2015. In this paper, the data is reported from first year modules with at least five student responses. This formed a dataset of 310 student responses including 228 responses from the Finnish language degree program in 16 modules and 82 responses from the English language degree program in 7 modules.

The Collaborative Knowledge Practices Questionnaire (CKP) is designed for investigating students' self-reported evaluation of collaborative working practices and competence development in courses [9]. In particular, aspects of collaboration and the use of digital technology are targeted as central components in modern knowledge work. These include learning to collaborate on shared objects (e.g., reports, products, designs), integrating individual and collaborative working, iterative development through feedback, understanding various disciplines and practices, interdisciplinary collaboration and communication, and learning to exploit technology. The questionnaire is based on the theoretical framework of the trialogical approach on learning that includes collaborative progressive inquiry [7].

The questionnaire had 27 questions on Likert scale and three open questions. The 5-point questions were of the type: "During the course/study unit I have learned… to develop products collaboratively by using technology." The answer choices were: "Not at all (1); Just a little; Somewhat; Quite a lot; Very much (5)".

3.2 Feedback from modules

The results showed that there were differences between the modules in how students reported learning of collaboration on a shared object, integrating individual and collaborative efforts, providing and receiving feedback, persistent development of knowledge objects, understanding practices of different domains, learning to carry out interdisciplinary collaboration and exploiting technology in collaborative activities. Fig 1 shows the results of the Finnish degree programs.

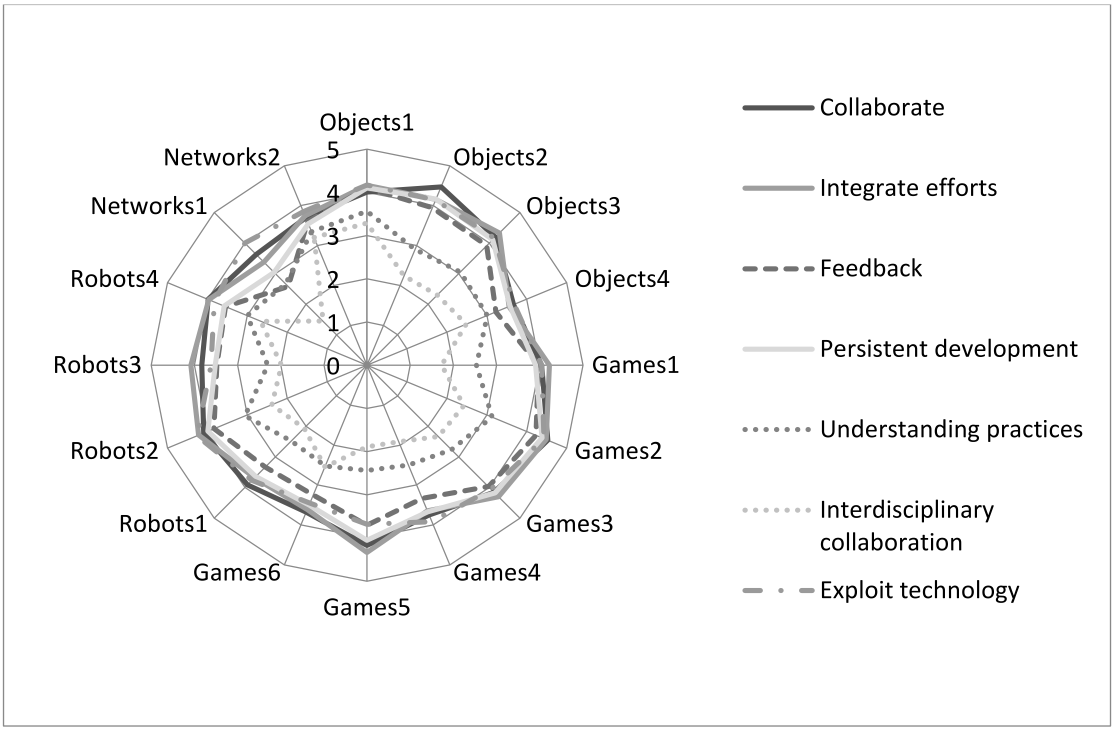

Fig. 1. Mean scores of the Finnish language degree program by course on the CKP questionnaire.

The international programs yielded generally even more positive results, as shown in Fig 2. On average, in the Finnish language modules, the students gave similar scores on four scales of the CKP questionnaire compared to the international program. On three scales there were statistical differences. They evaluated persistent development of knowledge objects ($t\ (116) = 2.64$, $p = .009$) higher, but understanding different domains ($t\ (132) = -3.61$, $p = .001$) and interdisciplinary collaboration ($t\ (174) = -6.34$, $p < .001$) lower than the international group. It appears that the international collaboration might have somewhat made the persistent development of their shared artefacts (designs, presentations, etc.) less efficient, but on the other hand, students experienced that they learned more about working with project participants with different backgrounds and about interdisciplinary collaboration. Overall the scores that students gave to the modules were high, suggesting that they experienced the project work pedagogical design of the modules beneficial for their learning. Of course, we did not receive responses from all modules, and cannot claim anything about their results.

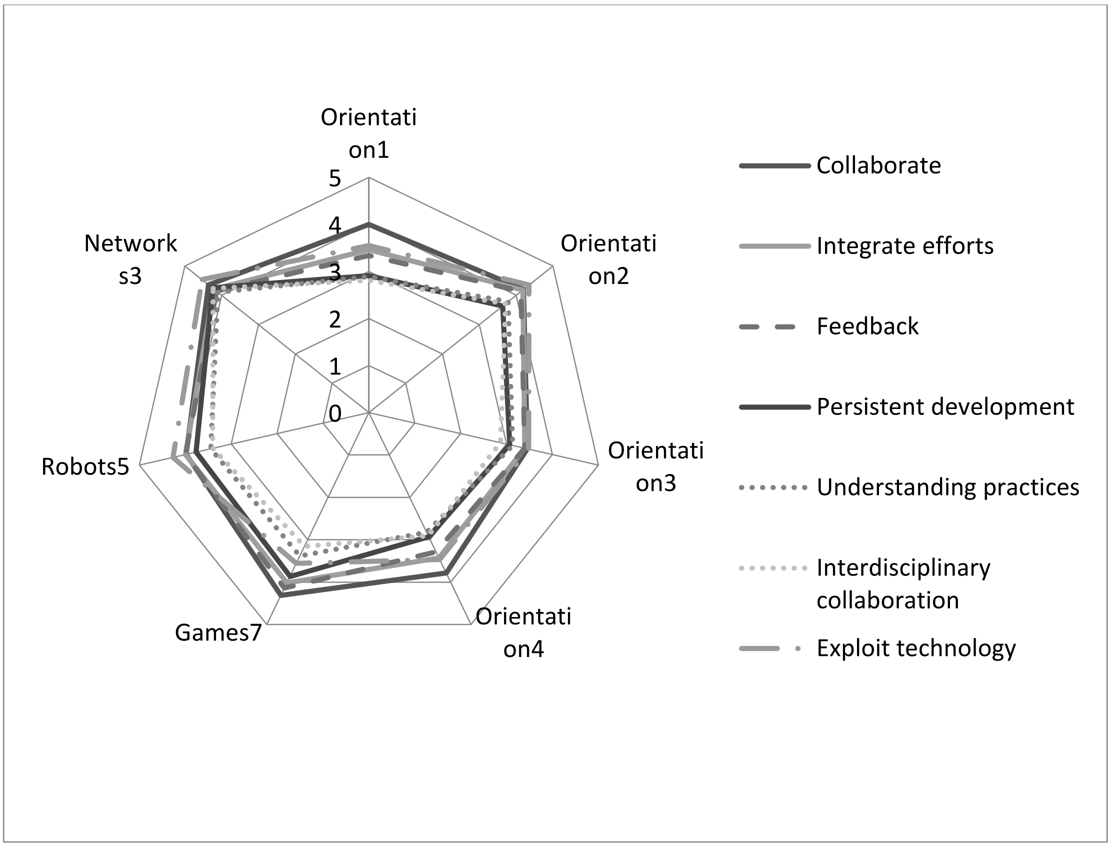

Fig. 2. Mean scores of English language degree programme by course on the CKP questionnaire.

3.3 Student views on module designs and teamwork

Additionally, we surveyed one group of students in March 2016 about their experiences of all the seven modules that they had until that point, namely 4 in the first year and 3 in the second. We received 29 answers, which covered about 80% of that group. The students were asked to evaluate the module designs, which we knew were varied. Student perceptions did not follow any clear pattern, rather, their comments and opinions were based on student impressions on teachers. Modules that had enthusiastic teachers, received praise disregarding their overall arrangements. When students had the impression that teachers were uninterested or unfair, teachers received criticism.

Comments such as too much or too little theory seemed to depend on who had given the lectures, and what was the respondent's inclination towards theoretical study. Basically, students seemed to be happy with clearly designed modules with straightforward goals. Project work started in some modules on the first week, and in some others only near the end of the module. Students expressed the wish to get the project early enough. On the other hand, the lack of a project in two modules was considered as a shortcoming.

The modules tried to achieve a variety of goals to different degrees. To reach an appropriate balance between theory and project work was an elusive aim. Student comments somewhat reflected their confusion on such a wide range of goals. Largely, students tended to focus on technical skills and completion of the product, and found other aspects including theory and communication skills as disturbing or burdensome despite their agreement on the importance of working life skills in general.

Additionally, based on the industry feedback we tried out including project communication exercises and small group meetings into few courses in the spring 2016. Small group meetings were well received by our students, but project communications would have required a better execution as students did not quite understand why the practise would be needed.

4 DISCUSSION AND CONCLUSIONS

This paper presents the outcomes of different course implementations in terms of student learning of working life skills. Certain positive outcomes were obvious, such as high student satisfaction and good retention rate [1, 10]. Nevertheless, the results were actually less varied between different implementations than anticipated, at least according to students' self-reported learning and how they described the module designs and teamwork. The change from large study groups, separate lectures and laboratories into smaller, tightly knit groups seemed to have been a decisive factor in improving the results in the first years. Belonging into a group and working in teams was a simple way to enhance commitment to studies and overall feeling of belonging, for students from diverse backgrounds in particular.

The initial results of project based courses were encouraging in terms of student achievements and adaptation to teamwork. The earlier course design that concentrated on separate tools and technologies appeared in this respect outdated. Therefore, project-based courses that combine technologies to a realistic development process, give a better understanding of challenges in the industry. Asides from teamwork, other industry skills such as project communication and professional conduct, seemed to be more challenging for young students. Furthermore, implementing these new practices is anything but straightforward, and requires substantial planning from the teacher teams.

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