A DESIGN-BUILD INTRODUCTORY COURSE IN INFORMATION TECHNOLOGY ENGINEERING

Janne Roslöf
Turku University of Applied Sciences
School of Telecommunication and e-Business
Joukahaisenkatu 3 C, FIN-20520 Turku, Finland

Abstract
As one of the first steps towards the CDIO adaptation, a first-year introduction to engineering course has been included in the curriculum of the undergraduate engineering program in Information Technology at Turku University of Applied Sciences. In this paper, the learning objectives, contents and implementation structure of the course according to the current plans are presented. It is described, how problem based learning cycles will be utilized to facilitate the learning process. Furthermore, one of the key success factors of the pilot course implementation, the formulation of the design-build assignment to be given to the student groups, is discussed and the community is encouraged to contribute the course planning process with their ideas and experience.

Keywords: ICT, Education, Engineering, PBL, Robots

Introduction

The B.Eng. degree program of Information Technology at Turku University of Applied Sciences (TUAS), Finland, joined the CDIO initiative fall 2007. As one of the first steps towards the CDIO adaptation, a first-year introduction to engineering course [1] has been included in the curriculum. The pilot implementation will take place in fall 2008.

The goals of the curriculum and course development are derived from the CDIO standard number four [1] aiming at providing a framework for the practice of engineering to the students, as well as strengthening their motivation for the field and relevant core disciplines. This goal well supports the earlier development actions of the curriculum, and also answers to the students' criticism on the too theoretically oriented focus of the first phase of the studies.

The introduction of the new course faced several both curricular and practical challenges. How to define the learning objectives and contents of the course to support the main discipline? What to remove from the existing curriculum? What type of a design-build project can be successfully implemented with new students in the field of Information Technology? How shall the student teams be tutored and the class room schedules designed? All these questions were discussed by the faculty utilizing the earlier experiences from problem based learning exercises, and the practices and encouragement of the CDIO community. The process led to a novel course in Product development within which the Information Technology perspective will, at least during

the first pilot implementation, be achieved using robotics as one of the core themes of the course and as the platform for the practical design-build activities.

In this paper, the background, learning objectives, contents and implementation structure of the course according to the current plans are presented. It is described how problem based learning cycles will be utilized to facilitate the learning process. Furthermore, one of the key success factors of the pilot course implementation, the formulation of the design-build assignment to be given to the student groups, is discussed and the session participants are welcome to contribute to the process with their ideas and experience.

Background and Challenges

Like many other engineering degree programs, the degree program in Information Technology at TUAS has experienced many students dropping out during the first and second years of study. Some students do not simply seem to be as active and motivated as they should in order to put enough effort in their studies; do the homework and attend the facilitated learning activities. Accordingly, course examinations are often delayed from the planned schedule. This is one of the main reasons behind the fact that too many students are unable to pass the courses in the planned order and, thus, to graduate within the planned duration of the studies. Moreover, the number of applicants to the program in the first place has also declined during the recent years, which does not make the situation easier.

Naturally, the problem as such has a very complex nature and certain dropouts have a quite acceptable background, at least from a teacher's perspective. Some students try after the first study year to enroll themselves in another university that they primarily preferred. Others may have found out that studies in Information Technology were not their true calling in the first place. However, despite the rather significant amount of students leaving due to acceptable causes, a problem still exists. Especially for the first and second year teachers the situation is frustrating. They may start their lectures with full classrooms but after some months the amount of absent students gradually grows and, finally, too many students do not pass the courses.

In autumn 2002, a project for developing and implementing new pedagogical methods in the program was started. The goal was, in addition to decrease the drop-out rate, also to improve, for example, the student's communication and team working skills [2], as well as to integrate the different disciplines together to some extent. That is, the very same elements on which the CDIO initiative [1] has been built on. The project led to a change in the curriculum that introduced a problem-based learning (PBL) implementation focusing in the first half of the studies. In brief, the PBL implementation meant in practice that the students face a learning assignment each week and this assignment is then solved and reported according to the PBL cycle. The assignments deal with integrated subjects connected to the disciplines the students are studying at the same time. That is, the whole curriculum was not implemented according to the PBL paradigm, but PBL was (and still is) rather utilized as a teaching and learning method together with traditional lectures, laboratory exercises etc.

The first PBL pilot started in September 2003. During the past academic years the structure of the implementation has been developed on the grounds of the students' feedback and the results obtained. Numerous methodological and practical problems have been faced and solved. Issues

like the learning environment including proper facilities and furniture, timetables, assessment and evaluation processes and routines, and curriculum adaptation have been tackled. The PBL implementation structure and practical experiences have been reported in detail by Tuohi and Roslöf [3], [4] and [5]. *Figure 1* illustrates the 2007 version of the curriculum structure. The courses marked with "PBL" contain multidisciplinary PBL assignments.

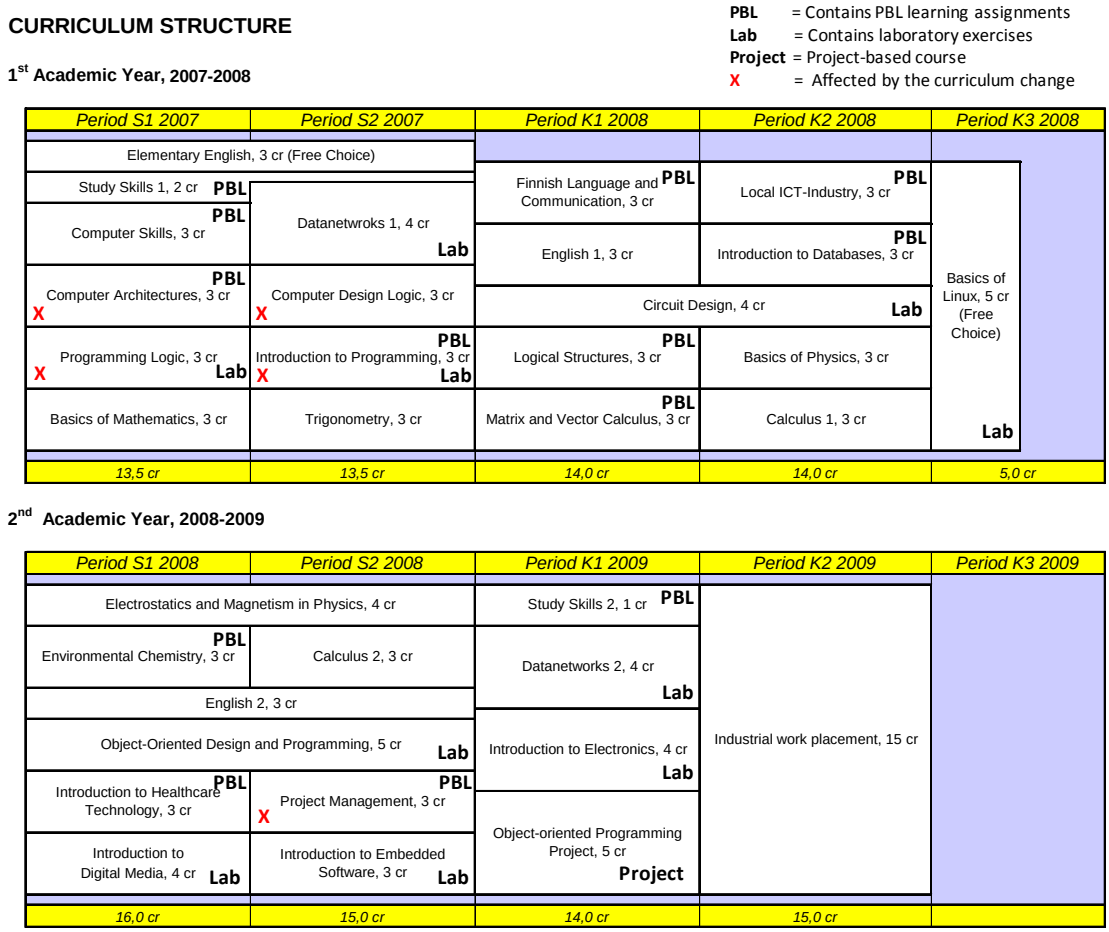

Figure 1. The original B.Eng. curriculum structure of the two first academic years.

The Next Phase – a New Introductory Course

A thorough analysis of the impacts of the PBL implementation in general is yet to be published. However, it seems that there has been a clearly positive effect on the goals dealing with the social competences. The team working and problem solving skills have been improved. Moreover, co-operation between most of the faculty members has clearly increased. However, the impact on the drop-out rate has, so far, not been that significant. In addition, the student's feed-back claims that the first year courses still are theoretically (too?) heavy, and that the PBL assignments do not support learning as well as planned; their connection to the disciplines is sometimes felt vague and the different assignments should be more connected to each other. That is, the next phase of the development was to be started.

Studying the CDIO initiative and its standards facilitated the process well. The concept of a project-oriented Introduction to Engineering course fit very well into the picture, and to complement the already taken actions in the curriculum development. After visiting Chalmers University of Technology and getting familiar with their proven experiences on practical first-year courses, it was decided to introduce a new project course in the very beginning of the studies. [6], [7], [8]

The introduction of the new course faced several, both curricular and practical challenges. How to define the learning objectives and contents of the course to support the disciplines? Obviously, introduction of a new course, especially in the very beginning of the studies, also requires that something must be removed from the existing curriculum accordingly. This led to many discussions with the faculty and, in practice, all first considered their "own" courses so important that they should remain intact. Moreover, many suggested that it would be far too difficult to implement a project course with the new students, most of which with minor or no competence, for instance, in programming or other related skills.

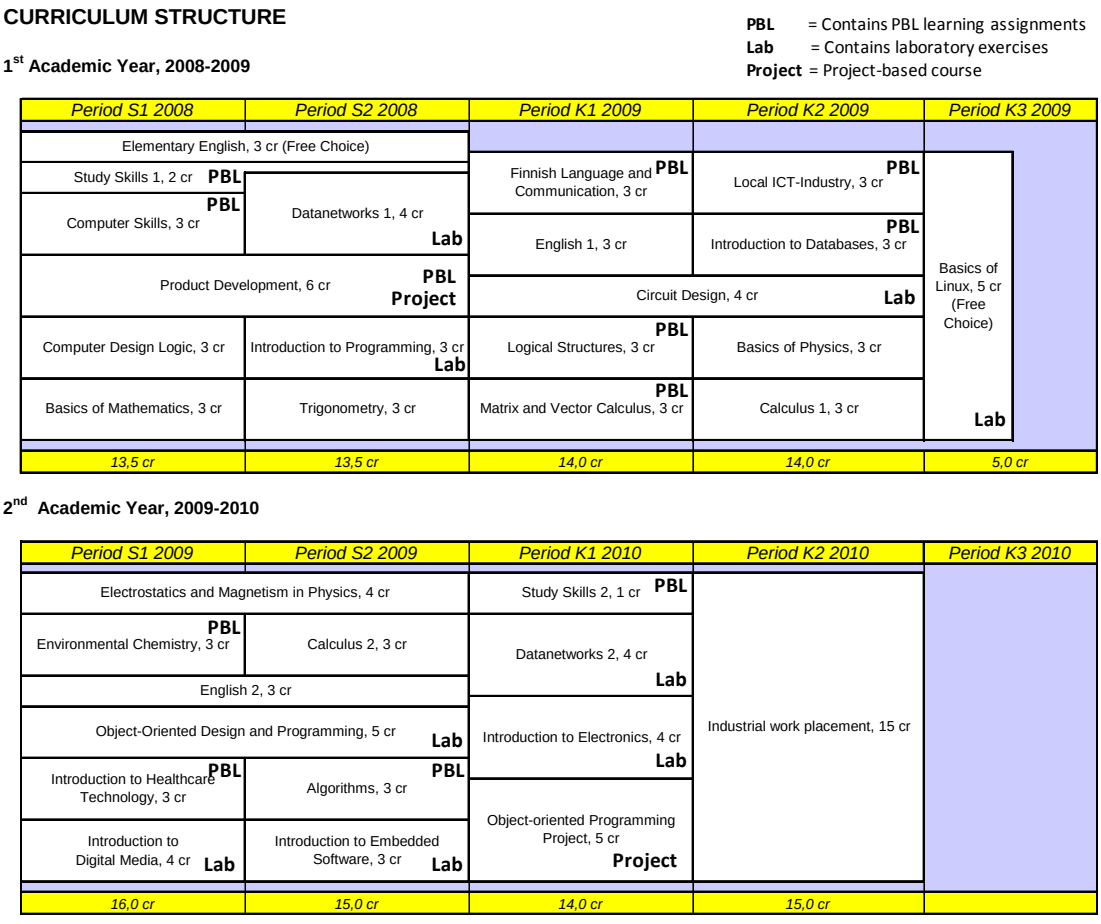

Figure 2. The updated curriculum structure after introduction of the new course in Product Development.

Finally, it was decided to create a new course in Product Development (6 ECTS credits) that would contain elements from Software Engineering, Computer Design and Project Management. The courses illustrated with a red cross in the *Figure 1* were reformed so that the new course partly took over the learning objectives of the old structure. The new structure is illustrated in *Figure 2*.

Course in Product Development – Current plans

After many discussion and brain-storming sessions it was finally decided that the course project would be using the Lego NXT robot kits [9]. Although the goal was not to teach robotics as such, the NXT provided an interesting platform that contains opportunities both in Computer Design, Software Development, Mechanics and general Product Development; and at reasonable cost. Furthermore, it might well be that the students would consider the task as motivating and even fun. At least the opinions of the student representatives were positive, and colleagues, for example, in Hamburg University of Applied Sciences and University of Turku had successfully applied the same platform in some their courses. And besides, who would never have dreamed on a career as a Lego-engineer…

That is, during the first implementation of the course autumn 2008 the student groups (9 groups of about 8 students) will face a product development challenge to be prototyped using Lego NXT. An example robot is illustrated in *Figure 3*.

Figure 3. An example of a robot built using the Lego NXT platform [9].

After the main decisions concerning the curriculum were made, a development project to plan the Product Development course in more detail was started in spring 2008. A prestudy performed by senior students including analysis of the NXT product and its capabilities was followed by a series of faculty workshops. In order to familiarize with the platform, the teachers were divided

in small groups and they all got a small assignment to be solved utilizing the NXTs (*Figure 4*). This exercise worked well, and it gave lots of experience and ideas for the further planning of the course. Most of the workshop participants got clearly exited and the general opinion considering the change improved significantly.

Figure 4. Teachers getting familiar with the Lego NXT platform [9] and its features.

At the moment, the course planning is still in progress. So far, the main learning objectives have been set, the course structure and working methods have been decided, and the preliminary weekly topics have been accepted.

Learning objectives
During the course in Product Development, the student shall in a practical project-oriented context:

- learn the main phases of a product development project,
- learn the central topics in general project planning and control,
- improve his/her problem solving and system building skills,
- improve his/her skills in communication and team work, and
- learn fundamental skills in Software Engineering and Computer Design.

Furthermore, a set of more detailed learning objectives will be defined based on the weekly themes (see below). Accordingly, the assessment criteria will be set based on the learning objectives.

Course structure and working methods
It was decided to utilize the previously developed and well-functioning PBL-cycles [4] to build the course schedule. That is, in the beginning of the course the groups will receive the main assignment with which they will work during the whole autumn, from September to December. The groups will use about 1.5 full days per week to work with the project so that the overall project will be supported by smaller weekly tasks facilitated by the tutor teachers. The weekly routine contains an opening meeting, lectures on selected topics, group work time and check-point meetings. In addition, there will be a weekly follow-up session to support the progress of the overall project. Tutor teachers and/or expert lecturers will be present with the students ca. 5 h/week. The other courses (see *Figure 2*) fill the remaining weekly workload of the students.

Weekly assignment topics
According to the current plans the course will run during 10 weeks that consist on the following themes:

1. Main assignment + requirement management
2. Project planning and control + documentation
3. Presentation of the platform: System architecture, Mechanics, Software Development environment and toolKit (SDK)
4. Programming 1: Procedural programming using the SDK
5. Sensors: Technology behind the platform sensors
6. Programming 2: Concurrent programming using the SDK
7. Quality and verification
8. Product marketing
9. New product introduction and commercialization
10. Final presentation of the project results

Further steps – and the central remaining question
Currently, the more detailed learning objectives and contents of the weekly themes, as well as the tutoring guidelines and assessment criteria are being planned. Everything should be ready in early June 2008 so that the first implementation can start in the beginning of the next academic year.

The main question that is still to be decided is the definition of the main project assignment. That is, how the product development assignment to be given to the student groups should be formulated considering the given learning objectives, themes and implementation platform of the course? Would a very open formulation (e.g. “Build a robot that solves a problem”) or a more specified one (e.g. “Build a robot that does X in the best and most efficient possible way possible”) lead to better learning results? Which type of assignment would motivate the students most?

The question will be discussed during the presentation of this paper. The CDIO community present in the session will be encouraged to share their experience on, especially, the first-year design-build courses, and to suggest suitable assignment definitions to consider. The results of the brainstorming will be documented and distributed to the participants afterwards.

Discussion

In this paper, the background, objectives and main structure of a novel design-build introductory course in the B.Eng. degree program in Information Technology at TUAS was presented. It was discussed how the curriculum has been developed during the last few years and how this latest change fit into the process and utilizes the earlier experience gathered.

The details of the new course are currently being planned, and the first implementation takes place autumn 2008. The central remaining question is how to define the main assignment to be given to the student teams. This question was discussed with the session participants and the result of the brainstorming will be utilized in the course planning.

References

[1] Crawley E., Malmqvist J., Östlund S. and Brodeur D., Rethinking Engineering Education, 2007, Springer. ISBN 978-0-387-38287-6.

[2] Roslöf J., "On the Quality of Future ICT Professionals - Defining Competence Requirements on Finnish ICT Engineers", Proceedings of the 13th European Conference on IT Evaluation, Genova, Italy, 2006, pp. 407-412. ISBN 978-1-905305-33-9.

[3] Roslöf J. and Tuohi R., "Experiences on a PBL Implementation in Engineering Education", PBL in Context - Bridging Work and Education, 2005, pp. 95-115, Tampere University Press, Finland. ISBN 951-44-6303-X.

[4] Tuohi R. and Roslöf J., "A Problem Based Learning Process Integrated in IT Engineering Education", Proceedings of The International Conference on Engineering Education ICEE, 2006, San Juan, Puerto Rico, USA. ISBN 1-58874-649-6.

[5] Tuohi R. and Roslöf J., "Practical Challenges with a PBL Implementation in Engineering Education", Proceedings of The International Conference on Engineering Education ICEE, 2007, Coimbra, Portugal, ISBN 978-972-8055-14-1.

[6] Houbak N. and Klit P., "Mechanical Engineering Curriculum At DTU And The Application Of CDIO In First Year Courses", Proceedings of The 1st International CDIO Conference, 2005, Kingston, Ontario, Canada.

[7] Cunningham G., Balson M., Bankel J., McCartan C.D., Putnam G. and Vandenplas C., "Comparison of First-Year Desig-Implement Experiences, theirs Assessment and Resources", Proceedings of The 3rd International CDIO Conference, 2007, Cambridge, Massachusetts, USA.

[8] McCartan C.D., Cunningham G., Bernard E., Buchanan F.J., McAfee M., Kenny R.G., Taylor I., Mannis A., "The Systematic Development of a New Introductory Course", Proceedings of The 3rd International CDIO Conference, 2007, Cambridge, Massachusetts, USA.

[9] Lego NXT Mindstorms, The LEGO Group Corporation. http://mindstorms.lego.com/

Biographical Information

Dr. Janne Roslöf is a principal lecturer in Software Engineering and degree program manager at Turku University of Applied Sciences (TUAS), Finland. He is currently heading the B.Eng. degree program in Information Technology (Finnish program in Turku), and the M.Eng. degree program in Technological Competence Management. His main interests are software engineering processes, decision support systems and industrial optimization applications. In addition, he as actively participated in the development of engineering education practices. Before joining TUAS he held several positions in industrial Telecom software R&D.

Corresponding author
Dr. Janne Roslöf
Turku University of Applied Sciences
School of Telecommunication and e-Business
Joukahaisenkatu 3 C
FIN-20520 TURKU
Finland

Mobile: +358 50 5985 438
janne.roslof@turkuamk.fi