EXPERIENCES OF THE FIRST YEAR INTRODUCTORY PROJECT IN METROPOLIA

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ABSTRACT

An introductory project in parallel with basic studies of mathematics, physics and electronics have been run on the second half of fall semester of electrical engineering degree programme. The learning outcomes are set to emphasize soft skills such as project management, team working, basic finance, time lining, marketing, and communications skills. In addition to those skills, CDIO ideas including the importance of engineering ethics and responsibility of the sustainable development are highlighted.

This project is using LEGO® Mindstorm robots as experiment tools. In the beginning the students are conceiving the challenge - how can they make customers happy with the available things. Secondly, they design and plan the products both the construction and functionality, including programming. Finally, the students operate the robot until it is cut into parts again and the box of materials returned.

Surveys about the students feeling about learning are done - and encouraging results received. As the construction and programming part of the project is considerably easy - the students are able to concentrate on the learning outcomes of project management - and still having fun. In the final competition of the robots one can easily recognize the joy of learning.

In this paper the results of the learning outcome and student satisfaction surveys will be analysed and the development plans of the course explained.

KEYWORDS

Integrated curriculum, introductory project, active learning
Standards: 3, 4, 5, 6, 7, 8, 10

INTRODUCTION

In Finland the B.Eng. curriculum in the Universities of Applied Sciences is planned to take 4-years. Programmes are based on secondary high school education or vocational technical education. During the first year in the University the students need to be able to strengthen the competences that are weak after their previous education. The students coming from senior high school typically master more theoretical things like mathematics and physics but have very little experience of engineering. On the other hand the students with vocational education

have more experience and understanding about the practical technical issues. The diversity between the students becomes even greater as several of them have already some years of work experience. To give a solid foundation for the engineering studies for such diverse groups of students is a serious challenge. This challenge gives also a great opportunity to benefit from joint learning from each other's in small groups. During the following years students are deepening their knowledge on sciences and engineering parallel with other competences needed.

The engineering programmes of Metropolia University of Applied Sciences are strongly empathizing the CDIO model (Schrey-Niemenmaa et al., 2010). Engineering curricula went through a major overhaul few years back, when practically all degree programmes designed the first year studies to employ integrated, problem- and project-based learning, combined with co-teaching methodology (Schrey-Niemenmaa & Yli-Pentti, 2011). There are plenty of evidence that the chosen methodology decreased the first year drop-out rate drastically indicating that the students' engagement to engineering studies improved (Karhu et al., 2010). The enhancement of the programmes has been based on continuous self-evaluation and cross-sparring with critical friends from different other universities and internally. The method is developed in joint projects with over ten universities around Europe. The system is completed in an ERASMUS+ project which finished 2016. This kind of systematic work has proved to be very beneficial and effective (Schrey-Niemenmaa et al 2016).

As an implementation of the new curriculum, the Electronics Degree Programme developed an introductory project integrating basic studies of mathematics, physics. The project is scheduled at the second half of fall semester. The learning outcomes are set to emphasize soft skill such as project management, team working, basic finance, time lining, marketing, and communications skills. Additionally, to those skills, CDIO Standards 3-8 including the importance of engineering ethics and responsibility of the sustainable development are highlighted.

This paper is introducing the first project of the curricula in electrical engineering. Surveys about the students' feelings and opinions about learning are conducted and encouraging results are presented.

FIRST YEAR CURRICULUM

The first year curriculum is divided into four modules - each of which takes 8 weeks. The students are evaluated from the modules with only one grade. That means they need to pass all the elements to pass the course. The required elements are typically taught by a group of 5 teachers. The teachers are cooperating and trying to add value to each other's content, which also enhances their teaching competences (CDIO Standard 10).

An introductory project is a vital part of the second module in the degree programme of electrical engineering. The learning objectives of the project are set in project management (including scheduling, budgeting, communication, risk analysis, self -evaluation etc.), team building and group working, presentations, basics of marketing, finding information, basics of building, and coding additionally to self- and group evaluation and feedback.

In the beginning of the course students are forming groups of 4 people. In some classes the

students are allowed to form the groups themselves and in some classes the teacher have made the decision. If the students can form the groups themselves they usually work with their friends and thus do not experience that much of “tolerating difficult colleague” or other challenging surprises. Sometime they then can even benefit from the pleasant atmosphere and can concentrate on other learning outcomes. However, in earlier studies we have found no significant differences due to method of group forming (Piironen et al., 2009).

The first task for the group is to collect a box of LEGO® Mindstorms and explore what is in the box. The content enables the building of a robot with different features. Then the group needs to start to search for information - what can be done with the content. Additionally they can decide what extra parts or materials they want to use. There are available a big box of spare parts from robots and from other LEGO® building series. Furthermore the group is allowed to bring in whatever they manage to get from elsewhere.

Next step is to write a project plan that will cover all the features of the learning outcomes. Additionally the tasks the project plan needs to include the following areas:

- Create a story of your robot to sell it to your customer - introduce the story in a 1 minute presentation to your potential customers (other students in the class). After the presentations the most attractive robot of the class is chosen in the first competition.
- How to manage the track of the second competition. The track is introduced after the 1st competition. It is about 4 meters long black line in a white background including a wall, where the robot needs find a detour. After passing the wall the robot needs to find the black line again and follow it until it hits a blue spot. In the second competition the time of running the track is measured and the quickest one is the winner.
- Finally the robots need to be undone, original parts returned to the box and other parts in their places.

At the end of the project the final report needs to be done. That report includes a self and group evaluation.

During the whole project the groups are following up their advancement with a diary. The diary includes notes of participation of the members, challenges they have met, learning points, and major inventions.

The evaluation of the project gives maximum 24 points which is 20% of the whole module. The points are granted:

- 6 points from project plan
- 2 points from the 1st competition including marketing speech
- 2 points from the 2nd competition
- 8 points from final report
- 2 points self- and group evaluation
- 4 points from the diaries

This division of the points is giving the students a clear message how important the different parts are. Especially the emphasis is given to the joint support to other students and constructive attitude. That includes also the responsibility of reporting internally in the group about schedules and unexpected problems. Failures in programming or other things are accepted - only a good analysis of the reasons is needed.

RESULTS AND DISCUSSION

Several methods of collecting feedback from the students have been used:

- The project final report has a compulsory part where the groups have to analyse the project from different perspectives: learning outcomes, one's own participation, colleagues' participation, joy of learning, matching to the curricula etc.
- Oral interviews of students regularly during the project in conjunction to the project diaries.
- Survey with anonymous e-form.
- Regular course feedback.

According to the feedback, students consider this type of learning rewarding and fun. In addition to playing with Legos in order to build and program robots, the students simultaneously learn the basics of project management. Although course evaluation is not based on the success in the competitions, they have a significant role in provoking enthusiasm and motivation for students to keep the project in schedule. Furthermore, in contrast to other parts of the module that are rather theoretical, students find such a practical exercise enjoyable.

Naturally, as the students have different backgrounds, they also have different competencies, when it comes to the skills that are practiced during this course. Furthermore, this has provided the students with an opportunity to learn from each other. Some of the students have not previously studied in teams whereas some have no experience in programming. Marketing and planning for schedule seems to be challenging for many of the students. Furthermore, carrying responsibility without doing everything by yourself, delegating and sharing have proved to be a good learning experience. Finally, the group- and self-evaluation have been appreciated among the students as in that form they are able to practice giving as well as receiving constructive feedback with their team members.

Some of the students have felt frustration when they are not able to find the solutions for the challenges, for instance, when they cannot manage to program the robot to act in the required way. As the teacher does not provide the students with the "right" answers or solutions, students might have stated: "you are the teacher - you must tell me". However, in these cases, the students have after discussion realized that the role of the teacher, in such a course, is to give guidance rather than to directly offer them solutions.

An interesting outcome of this course is that several of the groups have created additional properties to the robots even though those extra attributes were not required, but could even make the robot less successful (slower) in the final competition. These features have included, for instance; a robot that makes ice-cream while running and a rotating container of cream which was cooled down with ice. Another robot sang Christmas songs as the competition was just before the Christmas break. The third one made a fire work with plastic balls in the end of its journey to celebrate the arrival to the goal. These are just some examples of the inventions, each of the final competitions have definitely created a lot of laughter.

The anonymous survey was made about the opinions of the project amongst the students. 20 students from different groups answered the e-form questionnaire done by 3rd year students. The numerical results are shown in the Table 1. Additionally open comments were written and

the summary of the open text comments was very encouraging; this kind of course is a fun way to learn. As the theoretical problems were not too challenging they could concentrate to learn the systematic way of solving problems and understanding how many different aspects there are when an engineering project is done from Conceiving until Operate, including recycling.

Table 1. Results of the survey. 5 is excellent and 1 poor.

Question	**5**	**4**	**3**	**2**	**1**
Satisfaction of the course	30%	50 %	20 %	0	0
Workload	25%	65 %	10 %	0	0
Length of the course	20%	65 %	10 %	0	0
Learning of team work	20%	45 %	30 %	5%	0
Level of challenges	20%	60 %	20 %	0	0
Consumed time	60%	25 %	10 %	5%	0
Learning of project management	15%	50 %	35 %	0	0
LEGO® matching the purpose	55%	35 %	5%	5%	0

CONCLUSIONS

The LEGO® project has met very well its learning outcomes. Students have in many cases in the beginning been apprehensive about the LEGO® as University projects. But very soon as the students have started to work with the robots they have reached a level of enthusiasm that has really motivated them to continue. The joy of constructing and programming - leading to a working device have made the students to crawl on their knees around - and laugh. Afterwards they have been really amazed how much they have learned. In Finnish language there is a saying, which fits well on our observations “Those things you learn without joy you will forget easily”.

To make the engineering studies and profession more attractive to the potential students, it is utmost important to highlight the creative and fun side of engineering - as the future of the mankind is dependent on the responsible sustainable solutions for a huge range of challenges based on engineering knowledge (Schrey-Niemenmaa & Jones, 2015). This kind of start of studies with enjoyable learning experience has an enormous impact on retention of students and keeping them in engineering.

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BIOGRAPHICAL INFORMATION

Antti K. Piironen, Ph.D. is a Principal Lecturer of Smart Systems Engineering in the School of ICT at Metropolia University of Applied Sciences. He collaborates regularly with universities in Europe on topics related to joint courses, teacher exchange, and curriculum design. His current scholarly activities focus on the providing professional ICT engineering education using mixture of modern and traditional teaching tools and methods.

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