EXPERIENCES ON A CDIO INTRODUCTORY PROJECT TRANSFER TO A NEW TEACHER

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ABSTRACT

An introductory project 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 skill such as project management, team working, basic finance, time lining, marketing, and communications skills. Additionally to those skills, CDIO ideas including the importance of engineering ethics and responsibility of the sustainable development are highlighted.That project is using LEGO® Mindstorm robots as experiment tools. In the beginning the students are conceiving the challenges - 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. The first year project has been developed and fine tuned by the same teachers over several years. However, the fall 2017 change of teacher for a part of groups was evident, and therefore an interesting question arose: how well the the successor likes to follow the design and concept, or does the new teacher recreate the course again? In this paper we are presenting a case study on transferring a pedagogical concept when the teacher changes.

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 (Karhu, 2010); 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 (Crawley et al., 2014).

The introductory project was developed over several years by the same group of teachers. While a static situation enabled fine tuning of the concept, it was evident that the day would come when another teacher would take over the course implementation. Therefore, an interesting question arises: how well the the successor follows the design and concept, or does the new teacher recreate the course again? In this paper we are presenting a case study on the challenges of transferring a pedagogical concept when the teacher changes. Students' learning results were compared and both teachers were interviewed and their observations were compared.

INTRODUCTORY PROJECT

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 covers all the features of the learning outcomes. Additionally the tasks the plan needs to include are:

- 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.

CREATIVITY OR STANDARDISATION?

In Finland one characteristic factor of teaching in all levels is the freedom of the teacher. Learning outcomes are defined nationally for secondary level of education and by the University for Tertiary Education. The teachers, lecturers and professors are mostly allowed to decide their way of reaching learning outcomes in their own courses. That freedom leads to high commitment and responsibility to the teacher. Furthermore it motivates for continuous development of the execution of the courses.

As a teacher gets a new course to take care of it demands quite an effort to design. In that case it might be a smoother way to get ready instructions for the first turn and according to the experiences then renew the course gradually. Especially the need for instructions are required if a teacher gets with a short notice a course for instance in case when the standing teacher is temporary prevented.

Standardisation of the first year project course means clear description of:

- different steps of the course including schedule
- slide sets for teachers' lectures
- format for students' written assignments
- description of the evaluated non-written assignments

In the picture 1 is an example of the course plan. That kind of format can easily be adapted to the new groups.

Week	Tuesday	Friday	Obs
43	Lecture: what it means to be an engineer? Which competencies and skills are needed, what are the expectations of working life? How to learn, project based learning, CDIO, basics of project management. Starting the project	Conceiving the project Group Work	
44	Building, constructing, Conceiving the project, project plan	Building, constructing, Conceiving the project, project plan; Independently	
45	Building, constructing, Group Work Independently	Building, constructing, Group Work	Download the project plan latest on Wednesday
46	Feedback from project plan	Competition 1 Constructing, programming,	
47	Constructing, programming,	Constructing, programming, Independently	You can see the track on Nov 21
48	Constructing, programming	Constructing, programming	

49	Constructing, programming,	Competition 2 on the 8th December in room 504 (perhaps already on Thursday?)	
50	Undo the robot, count the parts, return the extra robot parts to "spare part box" and other extra legos to the big brown box. Return the cleaned robot box.	Finalize the reports	Download the final report latest 21.12.

Figure 1. Plan for the 8 week project course

Additionally the special occasions are needing an exact guideline as otherwise the temporary teacher might have difficulties on keeping in schedule, getting the expected outcomes and finalising the operate stage - recycle the materials for the future use. In the figure 2 there is an example of the guideline for the final competition. That guideline tries to guarantee that the students have a fair competition, all the groups get their results and the Lego-boxes will really remain usable in the future.

Final steps of the project course:

- Recycle the lego-box:
    - Undo the robot, count the parts, add missing parts, return the extra parts to the "spare part boxes";
        - § robot parts to plastic box
        - § extra motors and sensors to the separate plastic box
        - § other parts to the cartoon box
        - § broken parts to the shown box
    - fill the report sheet - leave in the box the report and the list of names.
    - after the teacher have accepted the box, replace it in the cupboard.
- Have a team discussion about the team work, roles and learning outcomes of the course. During the discussion and give feedback to each other and fill in the group- and self-evaluation form. Return the form individually.
- Finalise the "final report", please note that the report covers the whole project of 8 weeks. Pay attention to the learning outcomes, risk analysis, project management etc. Add photos and links to videos to the report. The technical attachment might include screenshots of the used code. One report from the team.
- Fill in the diary and submit - one final diary from the team.

Figure 2. An example of the guideline for the end of the project course

RESULTS AND DISCUSSION

The introductory project course was developed over several years by a teacher, who is a senior adopter of the CDIO principles in Metropolia. The new teacher in charge of the course was less familiar with CDIO. Furthermore, the situation was quite challenging because the teaching resource management was done late and the new teacher did not get sufficient time to prepare his own adaptation and plans in advance. The current and previous teachers met briefly few times to transfer material, concept, timing, and other necessary information to carry out the implementation.

The standardisation helped a lot and made it possible to offer the students the course despite the absence of the previous teacher. The new teacher mentioned that the standardization of the course did not limit at all his pedagogy, but quite the opposite released him from planning the course over again, and instead he could concentrate his efforts on teaching practices. Detailed instructions on implementation were considered very valuable in use.

When comparing the student's learning outcomes we cannot see any significant differences. Student groups did robots which performed similarly the same tests as previous student groups. The robots were also quite equally innovative as earlier. The drop-out rate remained negligible, and students' grades based on achieving the learning objectives sustained very good values.

Student feedback remained positive and constructive. Some students felt they would have needed more guidance on planning the project and writing the project report, which was also observed by both new and old teacher. On the other hand, we also need to remember that this is an introductory project, and the students will get more practice throughout the rest of their studies.

CONCLUSIONS

An introductory project developed and fine tuned by a teacher promoting CDIO was standardised and transferred to another teacher with almost none experience on the CDIO principles. The course standard was documented in detail, which allowed the new teacher to focus on teaching practices instead of detailed preparation of the course. The learning results did not show any significant differences compared to previous year's results. Still the motivation/introductory lecture in the beginning of the course was given by the teacher who had much experience of CDIO adaptation. That gave confidence to the temporary teacher and guaranteed the right message to the students. The students results documented were in the same range as they used to be although the feelings have no measurements that one can scientifically produce evidence. In our opinion, there is a growing need for more engineering education research in Europe on transferability of CDIO- based teaching modules (Ekström, 2017).

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