4TU. CENTRE FOR ENGINEERING EDUCATION

Establishing an ecosystem for Internet of Things

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Contents

1 Introduction 2
2 Goals and Objectives 2
3 Methods & Execution 2
3.1 Multi-disciplinarity 2
3.2 Entrepreneurship 3
3.3 Peer assessment 3
3.4 IoT Facility upgrades 3
4 Assessment 3
4.1 Evaluation Surveys 3
4.2 Individual student feedback 4
4.3 Peer assessment 4
5 Lessons learned 4

1 Introduction

This report provides information about the implementation and evaluation of the project *Establishing an ecosystem for Internet of Things* which was awarded to the Electrical Engineering department in December, 2018 by the 4TUE Centre for Engineering Education Innovation Funds.

In the coming sections we report about the learning objectives achieved, the implementation of the project itself, the evaluation of the project, the dissemination phase and the different involvement of the stakeholders.

2 Goals and Objectives

This project is a follow-up of the previous education project *Internet Of Things (IOT) innovation space labs*. Having identified what went well and what needs improvements, we set the target to establishing an ecosystem driven by student teams interested in bringing IoT solutions to existing problems. Fundamental aspect to achieving this was the DBL nature of the course combined with increased multidisciplinarity and entrepreneurial mindset of the students.

In more details, the objectives of the project were the following:

1. To strengthen the *interdisciplinary character* of the IoT project through the consolidation of active *collaboration* among the interdisciplinary teams' composition from different departments;
2. To introduce *peer review and assessment* as a method to intensify exchange of knowledge, stimulate deep learning and increase *collaboration* among interdisciplinary students' teams. The guidance of the interdisciplinary teaching staff involved in the IoT project is a key for success;
3. To develop the facilities within the *Innovation Space* location in order to make them available for the IoT project requirements.

Multi-disciplinarity would be intensified by both strengthening the contributions of other departments (namely ID, CS and IE&IS) to the project as well as by attracting more students with various backgrounds. Besides multi-disciplinarity, a stronger entrepreneurship component was the second ingredient which was expected to allow high motivation of the students to do their project and high relevance to real-life problems. This entrepreneurship component was also allowing for stronger cross-disciplinary collaboration between members of the same team. Finally, the peer assessment would help the students think of their projects from the user perspective and not only the technical completeness and soundness.

3 Methods & Execution

The project was executed following the objectives detailed above. The methods to reach those objectives are the following:

3.1 Multi-disciplinarity

Besides involving lecturers from ID and IE&IS departments, the time spent on lecturing and guiding the students with experts of those departments was significantly increased. Lectures increased from one two-hour slot to two two-hour slots. Besides that, the lecturers attended the weekly student presentations for the first half of the course to make sure their business modelling and product design follows the principles taught during the lectures. Moreover, the cross-discipline experts took part to the assessment panels we created for their midterm and final assessment. They gave their scoring per team and their feedback.

The second was of ensuring high multi-disciplinarity was to promote initially the course via multiple channels in other departments to make sure we have a good mix of student backgrounds and expertise. At the first week, we formed the student teams by first collecting the backgrounds of the students and their personal learning objectives. We took care each team to be a wide-spread of strengths with as less expertise overlap among the team members as possible.

3.2 Entrepreneurship

Within this project, we designed the course as a crash course of real-life purpose-driven startup creation process. That is, each team had to go through ideation, market-research, product design, product evaluation and execution phases. The only technical restrictions for the whole process were that the solutions offered to real-life problems had to include connectivity and distributed execution of tasks. From the process perspective, the students had to follow specific lectures and present to the whole class their achievements and road-blocks on a weekly basis. The feedback was continuous from classmates and the lecturers.

3.3 Peer assessment

Combining entrepreneurship, especially the ideation part, together with peer assessment was a challenging task. Ideation drove the groups to completely different paths which also loosened the understanding of other teams to the technical challenges and hurdles of another team. The peer assessment had to stay more abstract and focus on parts which have to do with the high-level technical design and IoT engineering approaches as well as business modelling. The peer assessment was formally used and considered for the final assessment of the groups. It was used to differentiate the grading between the members of each team. The assessment panel of topic experts was grading the whole team based on the final report and presentation of each team. Then each team member received a peer assessment form with which she/he assessed her/his teammates. The assessment panel used their own assessment of individual team members and those peer assessments to customize the team grade to individual grades.

3.4 IoT Facility upgrades

Prior to the deployment of the course in Q1, we spent effort on fixing several glitches on the IoT infrastructure (gravelnet) compared to last year. Moreover, we used resources to build sample assignments and test them over the gravelnet. Though that gave a boost to the IoT infrastructure for educational purposes, the ideation part and the not-so-restrictive prerequisites drove the teams to projects that did not require gravelnet. This is a good lesson for next year.

4 Assessment

4.1 Evaluation Surveys

The EvaSys surveys (available upon request) provided some information to be considered. While the overall assessment was three out of five, there is a list of positive and negative points. Some are available below:

- ✓ Difficulty level of the assignment: 3.5/5
- ✓ This educational form contributed to my understanding of the subject matter: 4/5
- ✓ he feedback I received was sufficient and useful: 4.3/5
- ✓ I gained new knowledge and/or skills from this project: 4/5
- × Each group member contributed equally to the project work 2.5/5
- × The educational setup (e.g. structure, content, teaching/learning methods, level, and coherence) worked well and was suitable for this project: 2.8/5
- × On a scale of 1 to 10, how would you rate this project (with 10 being “excellent”): 6/10
- × The assessment criteria were clear: 2.5/3

This evaluation allows for estimating the direction of improvements. The ideation part together with the short duration of the course created confusion as to the expected results and assessment criteria of

each assignment. Yet, the general feeling of the students was that the course is useful and they enrich their knowledge on the subject.

4.2 Individual student feedback

Unfortunately, the evaluation survey of the course collected input from a small subset of the students (4/21). In the attached the full evaluation. This is a general trend in several courses which was anticipated. We therefore implemented an individual feedback session from every student to the responsible lecturers. That gave rise to two needs: material/content on technical matters and the need of a close coaching of teams on organization and management aspects. This feedback allowed us react half-way of the course with closer monitoring of the progress of each team member and selectively try to motivate them cooperate closer and share load.

4.3 Peer assessment

The third component of the course evaluation was the peer assessment and the final feedback of the students to the course. The results of the peer assessment are shown in the tables below. Each table represents the grades given by every student (anonymized) to all his team members. Though the individual grades are not important, it was positive to see that no specific bias at peer assessment is obvious.

Figure 1 illustrates the distribution of grades from peer assessment over the whole student population. Note that these grades are not absolute but the result of a post-processing from absolute numbers to relative per group. That is, the highest grading of a student from his group peers was moved to 10 and the lowest to 0. The grades of the others was proportionally stretched. The bias from the expert panel was introduced here. These grades were determining the deviation of the individual grades from the group's average.

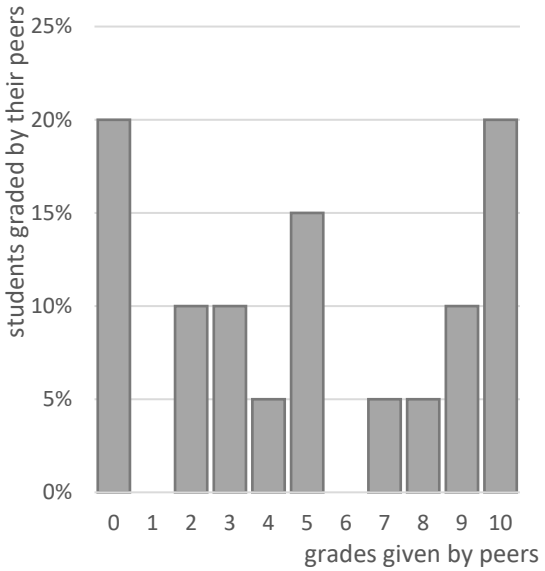

Figure 1 Distribution of grades to students from their peers

The second part of the peer assessment was dedicated feedback from the students to the course. That supersedes the results of EvaSys as all the students filled in the questionnaire. The personal view of each student is available upon request but is kept private for anonymity reasons. Yet, we concluded on several highlights of that feedback:

- Students appreciated the business angle that the course was giving to their efforts
- Project-based style and group assignments were also very well appreciated
- The diversity of tasks they had to perform on hardware and software was also well received
- Almost all students improved their technical and soft skills

5 Lessons learned

Future implementations of the course could rely on lessons learned from this project. Here a list of potential improvements:

- Add some more structured teaching of important technical components of the course such as telecommunications and networks
- Some more attention has to be given to coordinate the tasks among the teammates to make sure the workload is balanced

- More involvement from our side in breaking down the tasks so that the progress of the groups is more predictable
- Reduce the ideation part of the entrepreneurship aspects perhaps by involving the companies with their own assignments.