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IoT
Rapid-Proto Labs

WP6
Pilot 1 report

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Statement of originality
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Contents

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1. Pilot 1. Introduction

In this Pilot 1 Report we describe the evaluation of the curriculum of pilot 1. First, we describe the evaluation of the Smart Wheelchair curriculum of TUD. This is only based on the experiences of a HH student who participated the course as we did not receive any information about the evaluation from TUD. Second, we focus on the evaluation of the Multidisciplinary Software curriculum of HH. This is based on the evaluation data we have collected, including students' perception of the course, students' motivation in the course, and students' course performance. Last, discussion, suggestions, and conclusion will be presented. For the details of the settings of the two curricula of pilot 1 please see D4.4 Interim Curriculum Report.

2. Evaluation of Smart Wheelchair curriculum of TUD

This course evaluation is revealed by the bachelor thesis of a HH student who participated the course and his teacher's comments on it. According to the student, the course was well-organized and the course instruction was clear. Several course objectives (i.e. knowledge acquirement; collaboration with engineers; integration of software method; selection and use of suitable tools) were shared with students at the beginning. The content knowledge and relevant concepts were also well-explained. In addition, three benefits of the course were reported: a) student's freedom to work at his own space and time; b) student's increase of content knowledge and skills; c) the development of student's ability to develop a similar prototype after the course.

Several difficulties that the student encountered were also reported: a) the development of smart wheelchair was challenging; b) the scaffolding technologies used in the course were not stable; c) the interactions with other students were limited; and d) teachers' feedback for students who worked online was not timely.

The teacher was not satisfied with the student's performance. The student only received a grade of 2 out of 5 because he was more focused on building the prototype of an IoT-wheelchair which should have been only a side result in his thesis. On the contrary, the student did not achieve the most important goal, i.e. the analysis of the collaboration process with others.

3. Evaluation of Multidisciplinary Software curriculum of HH

3.1 Evaluation materials and instruments

The evaluation data for this course was collected by several materials and instruments during and after the course. These included student motivation questionnaire, student and teacher interview, student self-reflection essay, student online discussion, and teacher comment about student performance etc. The instruments of questionnaire and interview were designed by researchers and other materials were provided by the teacher.

Student questionnaire of Learner Motivation in Project-based Learning Course consists of three parts: 1) background information; 2) scale of students' perception of PBL course; 3) scale of students' motivation in following PBL course. Student perception scale was adapted from previous studies of Standage, Duda, and Ntoumanis (2005) and Chen et al. (2015). This scale measured students' perceptions of autonomy, competence, and relatedness in this course. One example of items is "In this PBL course I feel certain freedom of action". Student motivation scale was adapted from the studies of Ratelle, Guay, Vallerand, Larose, and Senécal (2007) and Vansteenkiste, Sierens, Soenens, Luyckx, and Lens (2009). This scale measured students' intrinsic motivation, extrinsic motivation, and amotivation in following the current course. One example of items are "I am following this course because I am highly interested in doing this". Students were required to choose a number between 1 (completely not applicable) and 5 (very applicable) from the scale. Three open questions were also asked after each scale in order to get students' further feedback and opinions.

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Student interview was designed mainly based on the results from the student questionnaire. In this way, we could explore the reason behind students' choices regarding their course perceptions and motivation. In addition, we also asked about students' their learning process, both the benefits and difficulties of the course, and their suggestions to improve the course in the future.

Teacher interview was designed to investigate the teacher's satisfaction with student performance in this course. Seven elements of PBL course from Kolmos, de Graaff, and Du (2009) were adapted for the interview. These elements included course objectives, driving questions of the final product, students' progression, students' collaboration, the role of the teacher, the use of educational technology, and course assessment etc.

3.2 Participants and data collection

Three students out of four responded the student questionnaire (with the consent letter) via the system of Qualtrics provided by LU. Two of these three students agreed to participate in the follow-up interview. One of the researchers from LU interviewed them individually by Skype. Each interview took approximately 50 minutes. Before the interview, both students signed the consent letter for the student interview in Qualtrics.

One of the teachers of this course was interviewed by the same researcher by Skype. The interview took about 50 minutes. Before the interview, the teacher signed the consent letter for teacher interview in Qualtrics.

Other materials above-mentioned were provided by the teacher via emails.

3.3 Evaluation results

In general, students interviewed evaluated this course as a useful course which was better than other courses they took. The benefits of the course consisted of two parts. First, it provided students with a real working environment, in which students had enough space to achieve their innovation and could be responsible for themselves. Second, students learned new knowledge, practiced the way to do research, and improved their team working skills. Thus, their course-related confidence might have increased.

Two main difficulties were also reported by students. The biggest challenge of this course was the lack of clear task division. Thus, students did not know exactly which parts to work on, which may lead to their fluctuation in course motivation. Also, the whole course took approximately five months, which was too long for students to focus on.

3.3.1 Students' perceptions of the course

Students' perceptions of their autonomy during the course, competence to accomplish project tasks, and collaboration with peer students were revealed. In general, students felt much autonomy in different phases and the whole process of the course. They could choose any activities they liked to work on. They could also decide which solutions to implement and how to do that. Additionally, if there was something wrong, they were free to do changes to the original idea.

Students had different levels of competence to follow this course. One student reported little confidence and ability to complete project tasks. This was mainly because he was not familiar with the course itself and the solutions needed to work on. He also mentioned that the tasks were better to be done in a group rather than by the individual. On the contrary, another student reported a high level of confidence and competence to take the course. There were two reasons for this. First, previously he attended similar IoT courses and had some course experience. Second, although he had little confidence regarding coding, he had a lot of experience related to hardware, which made the coding even more interesting.

Overall, students were satisfied with the collaboration among group members. Their division of labor was clear. For example, one student worked mostly on hardware while others focused on

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software. They got along and communicated well with each other. They also supported and helped each other. For instance, if someone was stuck on something eventually everyone would concentrate on that, and then they would discuss and try to solve that problem. However, there were some difficulties with collaboration. The most serious one was group members' weakness with the project topics and techniques. Other problems included low attendance for group discussion and limited skills on time allocation and utilization etc.

3.3.2 Students' motivation in the course

The motivation in following this course of some students fluctuated during the learning process. At the beginning of the course, students were excited and enthusiastic about the IoT idea and equipment. Then the motivation of (at least) one student started to drop after about one month because he did not know what to do and felt that he could not contribute to the project as much as the beginning. Another student's motivation suffered towards the end when nothing seemed to progress. This might also because, according to the teacher, that the project was not like what the students expected and wanted to do as they have had less train for hardware in previous courses.

3.4 Students' course performance

According to the teacher, there were two important course objectives. First, students need to develop the ability to learn new programing related technologies. Second, they should learn how to define a project and divide the work among the group. The acquirement of content knowledge, however, was the least important aim of the course. Therefore, the teacher was not satisfied with student course performance as none of the most important course objectives were achieved.

Student performance was evaluated by five methods of assessment: a) teacher observation; b) teacher-student discussion; c) student self-reflection essay; d) student peer assessment; and e) final product performance.

3.4.1 Teacher observation and teacher-student discussion

During this course, the teacher mentored and assessed students' performance via his class observation and talked with students. He observed what and how students worked on the solutions for the project and discussed the problem they encountered. He also gave may hints and f2f instructions to the students, showed the process of solving problems, observed how well they adopted and applied those instructions to their work, and assessed their performance based on that. At the end of the course, the teacher and students had discussions about how far the students got and how well they worked and made an agreement about their course performance.

3.4.2 Student self-reflection essay

Student self-reflection essay consisted of seven parts. The first part required students to describe the aim of this project as they understood. All students thought the course aimed to implement a prototype of the queue monitoring system. However, as discussed earlier, this is students' misunderstanding of the aims of this course. The second and third parts asked students to describe what and how they did in each stage. In the fourth to sixth parts, students gave self-assessment based on what they did well and what could be done better. Most of them reported doing well at the beginning of the project by, for example, helping with technology. However, there were still needs to improve communication between team members. In the last part, they assessed their peers' performance.

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3.4.3 Student peer assessment

Students gave each other a final grade from one to five at the end of the course as the assessment of the performance of their classmates. Some assessment criteria were given by the teacher in the online discussion forum: a) overall contribution to the project; b) availability and contribution to teamwork; and c) contribution to joint learning. However, these criteria were loose and weak as there were no specific instructions for grading. In addition, students interviewed formed different reasons for grading, which were mainly based on their perceptions and observations. For example, one student said "(I observe) what they did wrong and how they could be improved" and "were they active doing the classes". Another student used some criteria like "how much work they did" and "how much were they were trying to do". As a result, the scores of the peer assessment were different from and (much) higher than the grades that the teacher gave (4.3/4; 4.6/3; 3/2; 2.6/1).

3.4.4 Final product performance

The final product of this PBL course was a prototype of a queue monitoring system for cafeterias that required a lot of skills of both software and hardware. The main driving question behind this product was to find a way to train students to use new technologies. Another driving question was related to the real needs of the school cafeteria.

Since the feature of developing final products differentiates PBL from other forms of education (Blumenfeld et al., 1991; Helle, Tynjälä, & Olkinuora, 2006), it is vital to assess the final product that students created. It turned out that the teacher was not satisfied (grade 2.5 out of 5) with the queue system that students made. There might be two reasons for this. First, some students lacked competence in hardware skills because they haven't been trained for hardware in any previous courses. Second, at least one student reported that he joined this course with little background knowledge as the course did not require any of it.

4. Discussion and suggestions

The most significant finding from this evaluation was that there was a gap between the course aim that students achieved and the aims that the teacher wanted students to achieve. In specific, students reported the improvement of their content knowledge and skills, which from their perspective, was the most important course aim. Nevertheless, none of the three important course objectives that teacher believed, i.e. the analysis of the collaboration process, the ability to learn new technology, and the competence to define and divide problems, were achieved.

There might be three reasons for the gap. First, the course aims were not clear. There was a lack of specific sub-goals of each aim and feasible approaches to achieve it. Second, students lacked the competences to achieve the higher-order goals. This was demonstrated by, for example, students' little experience and training for both software and hardware. Third, the teacher interfered students' independent thinking. Although students should be encouraged to communicate with teachers, this, however, does not mean that the teacher should actively offer help to students before students ask for help (which was the case in the HH course).

Therefore, several implications and suggestions for the future are provided. First, the aims of future courses should be divided into specific and feasible sub-aims. In doing so, teachers could set criteria for each sub-goal and evaluate students' performance accordingly. It is suggested that teachers and researchers work together to achieve it. Second, students' prior knowledge needs to be checked and relevant course training should be provided to help them match the course aim. Third, teachers should be aware of their role in PBL courses. Instead of actively offering help, teachers could show their availability to students and work as a facilitator who assists the learning process of students (Gavin, 2011; Tseng, Chang, Lou, & Chen, 2013).

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Possible solutions for other problems students encountered were provided: a) to make peer assessment more effective in future courses, clear and consistent criteria for peer assessment should be provided to students by teachers; b) in order to decrease the potential side-effects on students' course motivation, the duration of future courses can be considered shorten. A meta-analysis conducted by Chen and Yang (2019) and the study of Larmer, Ross, and Mergendoller (2009) recommended 2 to 5 hours implementation of PBL per week.

5. Conclusion

Overall, students were satisfied with the courses. They were interested in the real-world working environment and satisfied with peer collaboration. They also reported the improvement of their content knowledge and skills. However, the teacher was not satisfied with the students' course performance as he believed none of the significant course objectives were achieved. Future courses need to put effort to set clear course aims and improve students' competences.

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