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INTERACTIVE PROJECT-BASED TEACHING – MEETING THE CHALLENGES OF THE COMING GENERATIONS OF STUDENTS

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Abstract

Experiences from the authors' teaching indicate that students are becoming less focused on educational exploration and critical thinking. In parallel, Broo, Kaynak, and Sait (2022) highlight that future engineers must be fluent in different technologies, methods, and methodologies. Hence, the fast changes that take place require a highly dynamic capability among the workforce of tomorrow, which is opposite to many students' behavior in teaching and courses. This sheds light on Project Based Learning, in its essence, student-centred and with a dynamic approach to teaching where students study real-world problems and challenges (Kokotsaki, Menzies, et al. 2016). Similarities exist with Problem-based learning, where complex real-world problems are also at the centre to promote student learning. Both these concepts can promote the development of critical thinking skills, problem-solving abilities, communication skills, and the possibility of working in groups (see, for example, De Graaf and Kolmos, 2003). This research report documented experiences involved in moving from a more traditional teaching approach into a more project-based approach regarding a course in construction management, undertaken four times with a new structure in which a problem-based approach was developed. One of the key issues at hand with the course was to develop it and stimulate students interest in the course subject, i.e., intrinsic motivation (Entwistle, 2009), motivation that comes from "*interest in what is being learned and feelings of pleasure derived from it*" (pp 20), and not from external rewards (extrinsic motivation). Based on previous experiences from project-based learning, course material has been developed in four rounds, where each course provided feedback to develop the course further. The course focused on an already conducted construction project, which was modified for each round so the students could create new frames for the project. Feedback was received during the course, and individually, students at the end of the course provided feedback to coming rounds. The results from this development show interesting challenges in teaching regarding the balance between showing results from the actual project vs. stimulation of creativity among students, with a clear conclusion that age, and work experience positively affect how the students execute the projects. It also directly shows the significance of the course framing and the variation of project set-ups in the course. Our findings also show values in PBL for students' ability to handle changes in a world with many insecure influences.

Keywords: *Problem-based learning, project-based learning, intrinsic motivation, flexible learning.*

1. Introduction, motivation, and objectives for the paper

The authors of this paper have extensive experience in teaching over the years. Altogether, the authors' teaching experiences include different subjects at different university levels. These experiences and discussions with colleagues indicate that students are becoming less focused on educational exploration and critical thinking. The focus here is construction engineering, and Broo, Kaynak, and Sait. (2022) highlight that future engineers must be fluent in different technologies, methods, and methodologies. Regarding this, the Architecture, Engineering and Construction sector is no exception, where climate impact pressures and technological advancements sets demands on broad skills among its professions (Chacón, 2021). Hence, the surrounding world is going through fast shifts which cannot always be foreseen but puts emphasis on a high dynamic capability, i.e., to adapt to upcoming circumstances to be competitive (see for example Meier et al, 2023) among the workforce of tomorrow. In this setting and under these circumstances, Project Based Learning can be a valuable teaching

approach. This is, in its essence, student-centred with a dynamic teaching approach, where students study real-world problems and challenges (Kokotsaki, Menzies, et al. 2016). A similar approach is Problem based learning, in which complex real-world problems are in focus to promote student learning, i.e., both concepts can promote the development of critical thinking skills, problem-solving abilities, and communication skills and possibilities to work in groups (see for example De Graaf and Kolmos, 2003). Perrenet et al. (2000) states that a similarity between the concepts is that they both emphasize self-direction, collaboration, have a multidisciplinary orientation and are founded in real-world problems. Hence, both approaches can be valuable in addressing challenges with students and their learning focus, as stated above.

This paper presents documented experiences involved in moving from a more traditional teaching approach into a more project-based approach regarding a course in construction management, undertaken four times with a new structure in which a problem-based approach and project-based approach were developed. The paper aims to provide learnings for other types of education aiming to transform into this type of education.

2. Method

Relating to the aim of this paper, the background, and motives for the change of the course, as well as changes and feedback from the students, are described. In addition, the mean age and experience of the student groups are described. One of the authors has actively been involved in developing the course set-up and documented the progress and student feedback.

For Higher Vocational Education (HVE, see below under 2.1), the students had, as a part of the course assignments, to describe their learning process over the course, write a diary, and evaluate the execution of how the project group had been working together. In this, there was feedback on the course set-up and development. In addition, an evaluation was made by the program director, and the students filled out a formal survey. For Halmstad University (HU, see below under 2.1), the students were given an assignment to write a diary and an evaluation of the project and the project group. In addition, the students did a course evaluation at the end. Besides that, a structured evaluation was made in class to discuss the course and its execution in the final class. Altogether, these activities are used to identify areas of improvement for the next round and is on an aggregated level which the students know that it is used for and it is this aggregated information that is used in this extended abstract.

Since one of the authors has been active in the development, this influences the interpretation of the development and the information presented in this paper. Therefore, the second author takes on an important role as critical reviewer besides giving the perspective of an outside view. This is a major part of creating credibility in the results, including reflection of the methods weaknesses and risks (Maxwell, 2012). The critical awareness of the method is also important to create trustworthiness, and here, the outside view of the second author is of central importance (Merriam, 1994).

3. Development of the course(s) in Construction management

In this section, the background of the course is described, as well as changes made over the different course rounds. The course has been given at two schools in different rounds, where the content differs due to level and overall education objectives.

3.1. Background and changes to the course

Several years ago, one of the authors worked heavily with transforming different engineering education programs from mostly so-called traditional teaching into a teaching approach based on project-based and problem-based learning. This covered only part of the education programs, i.e. half the teaching over one semester in each year of education. The experiences from this were overall sound, and students already in the first semester produced impressive results in their projects and abilities to bring unexpected ideas and solutions (not all students, though). This positive experience has, from then on, been more or less a key ingredient in one of the author's teachings.

Within the Department of Construction and Energy Engineering, specifically regarding the Construction Engineering program, there has been a discussion about how the development of teaching can be developed into a more problem-based approach and project-based approach, stemming from a discussion about the student's attitude toward their studies. Teachers have experienced students often seeming narrow in their views and often expressing a need for clarity in what to do and achieve. This is important in any education, but patience, the ability to grasp what is expected, and taking one's own initiative for learning have been seen as an area of development potential. Therefore, a change in the design of the studies has been seen as vital to stimulating explorative learning. In particular, teachers were

experiencing a student attitude aimed at having very precise instructions that could provide answers, which in many cases is typical for courses in design that include dimensioning/calculations. The course in question for this paper is a course in construction management, basically covering the steps of building design and all activities needed to hand over a finished building. The course provides an overview of the construction process but does not go into depth in sub-areas since this is covered in other courses. Hence, since the students had been complaining about it being hard to grasp and seeing the practical benefits of the course, this provided a good opportunity to redesign the course.

In parallel, some of the teachers in the department, including one of the authors, had a similar but shorter course at a 2-year education program, a Higher Vocational Education (HVE). HVE was a two-year education with a more practical orientation and included work practice. This course was given once a year but proved helpful as a first test of a revised course set-up, emphasizing project and problem-based learning. The student population was different concerning both age, no of students and experiences. HVE round one (HVE1) had an average age of slightly over 30 yrs and almost half were women and round 2 just under 30 yrs (HVE4) and around a sixth women. HVE was mainly consisting of students that had worked and came from many different backgrounds, including the construction industry. HU2 had an average age of slightly under 25 yrs and nearly half of the class were women. while HU3 had an average of slightly over 20 yrs with about a third of the class women.

The original courses, called HU, took place at Halmstad University and are part of two types of bachelor-level education programs, and HVE, taking place at the two-year education program mentioned above, depending on their location, were basically structured as follows. HU consisted of lectures and exercises, and the exercises were 1 ECTS, a project assignment of 3 ECTS, and an exam of 3,5 ECTS credits. The project assignment was, in short, to create a document for procurement of a building project; the exercises revolved around using different types of projects and the exam about the course aims. The project covered time-planning and costs associated with the building project, and the course mainly had one day a week dedicated to teaching, while the rest of the time was dedicated to the student's studies. HVE had a bit of another set-up, with three days of classroom activities consisting of lectures and exercises. The whole course was then examined through a written exam.

When changing the courses, the basic idea was the same. The main objective was to go through the steps of building an industrial facility, including a warehouse, office, and social spaces. The students had project assignments relating to start-up activities and then had to conduct project activities related to a construction project from start to finish for each week. By doing this, the students should also be trained in visualizing and understanding systems and structures, which is essential in the construction sector (Mastrolembo Ventura et al., 2022). In HVE, the students worked with the project, its assignments, and documentation in a PowerPoint presentation, with ongoing presentations of the project activities and feedback provided regarding the assignments. In parallel, the students had individual assignments to hand in each week, which were about answering reflective questions about that week's themes. For the HU course, the basic set-up was the same, but the students had to conduct a report for the project, including a final presentation of the project, which was supposed to have a selling approach. Since the HU course was more significant to its extent, the assignments were also more extensive.

3.1.1. Feedback and changes over the rounds. Each time the course has been executed, there have been changes. The first time the course took place was, as stated above, the HVE1. The second time was at Halmstad University (HU2), the third time at Halmstad University (HU3), and the fourth time at HVE (HVE4).

HVE1: The first time the course took place, it was deemed successful overall as it was considered interesting, but also with many areas the students wished to go deeper into. The course evaluation survey had a response rate of about a third of the class answering and a mean satisfaction value of 4,25 (out of 6). Main comments were that the structure of the learning platform was messy, and to many teachers involved and at times messy with the individual assignments and the communication between the teachers. On the positive side, though, it was good with the individual assignments and the projects. In addition, the course was considered interesting and valuable, and the teacher's knowledge was considered good with many new subjects. Judging from the learning process descriptions, the course was deemed successful overall, with about a sixth of the students disappointed but the rest satisfied (or more). A main issue that the teachers reflected on was that the students were not challenged in different types of designs regarding the facility. It was much the same, and it was also concluded that they should be provided costs at an early stage to enable an assessment of the design.

HU2: With a basis from HVE1, different groups were provided with different demand specifications and a more thorough review of different building systems and costs. To the demand specification it was added that the students should choose a possible customer to adapt the building towards. In this course, they were also given more frames to change the design and evaluate their design

regarding cost and climate impact. Many of the student groups made a 3D model of the building in the software Revit, which was a good addition to the projects. A main complaint from the students was that they thought they had too much information and sources and that it was hard to assess how much the report should contain. Otherwise, the groups presented buildings with different designs/architecture. In the oral evaluation, students raised the point that they thought there was too much material, which was discussed, with the point being that the students need to learn how to find facts. The course evaluation had a response rate of about a third of the students answering and a general satisfaction index of 67 % (out of 100 %) On the positive side, the students found that the project and the exam were good and interesting, including the set-up with weekly assignments. Once again, the students complained about the learning platform's structure, and some thought the amount of work was too much, although a majority assessed it as fair.

HU3: This time, a demand specification was added to broaden the scope of buildings. In addition, a template with headlines and additional instructions was added to clarify the content of the report and the project. It also became mandatory to make a 3D model using the software Revit. In the oral evaluation, students again raised that they thought there was too much material, which was discussed, with the point being once again that the students need to learn how to find facts. The course evaluation had a response rate of about a fifth and a general satisfaction index of 61 %. Once again, the students found that the project and the exam provided an understanding of all the parts of a project and that the high amount of practical work was good and interesting, including the set-up with weekly assignments. Also, the students complained about the structure of the learning platform and that the students found that the teachers were not synced, which had to do with a new teacher coming in to the course previously unused to the course and its set-up.

HVE4: The added changes were used again, this time in the project. In addition, due to previous criticism, the main author took over more of the course to manage a more significant part of the course. Since these students studied a limited version of the project, the visualization in Revit was not part of the project, and some of the parts were smaller in the project. Again, the course was deemed successful overall as it provided good basic competence and many good learning areas, but more depth in some areas was stated as helpful. The course evaluation survey had a response rate of around 70 % and a mean satisfaction value of 4,7 (of 6). Some individual comments were that some parts could have a higher pace, and some students still felt that too many teachers were involved. However, judging from the learning process descriptions, all course participants expressed satisfaction with the course.

Planned for next round was that the students were given a real area to plan the building project on. The area was under planning within a municipality, where the buildings in the projects can be built. This addition was made to further enable different types of designs and projects and possibly also add possibilities for different types of architecture.

4. Discussion

One of the key issues at hand with the course was to develop it and stimulate students' interest in the course subject, intrinsic motivation (Entwistle, 2009), i.e., motivation that comes from "*interest in what is being learned and feelings of pleasure derived from it*" (pp 20), and not from external rewards (extrinsic motivation). As seen from the evaluation summaries, there is a variance regarding students' satisfaction. An indication is, however, that older and more experienced students seem to cope with the approach better than younger students. However, there is still a dilemma with several issues in the approach. Firstly, the structure of information can constantly be improved. However, the balance between providing very clear instructions and letting the students set the frames themselves seems to be an ongoing development route where more clarity can be improved, but the level of innovativeness in the projects must also be supported and encouraged.

An example is that the students initially think the project is unclear, but it becomes more apparent as they go ahead. This phenomenon seems to be more stressful for younger students than older ones, and younger students ask more questions regarding what to do. In contrast, older students ask more questions about knowledge and its application. The students experience the setup differently depending on personal attributes and experience. At large, the HVE students generally, although being a smaller group, seem to have a greater interest in learning. In addition, the impression is also that they can manage undefined issues better than university students, which most likely can be related to their experience in managing issues in real life.

There is also a challenge in how many teachers should be involved, and an easy conclusion seems to be that one teacher should have a majority of the course, validated by HU2 and HVE4. However, there is also a learning process among teachers to get into the approach, which is also valuable.

5. Conclusions

Based on previous experiences from project-based learning, course material has been developed in four rounds, where each course provided feedback to develop the course further. A main driver has been to increase creativity and variation in the projects but also to meet the students' wishes to improve the course. Working with problem-based and project-based learning is a learning skill, and handling undefined activities is a competence that also needs to be developed to manage changes in a real-life work environment.

The course focused on an already conducted construction project, which was modified for each round so the students could create new frames for the project. Feedback was received during the course, and individually, students at the end of the course provided feedback to coming rounds. The results from this development show interesting challenges in teaching regarding the balance between showing results from the real project vs stimulation of creativity among students, with a clear conclusion that age, and work experience have a positive effect on how the students execute the projects. It also directly shows the significance of the course framing and the variation of project set-ups in the course. Our findings also show values in PBL for students' ability to handle changes in a world with many insecure influences. It should also be acknowledged that learning among teachers is also a significant part of the development process. Finally, the wide frames of the set-up seem to stimulate creativity but also need to be balanced with good enough instructions.

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