Developing Teamwork Skills Through Simultaneous Group Project Courses

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DEVELOPING TEAMWORK SKILLS THROUGH SIMULTANEOUS GROUP PROJECT COURSES (RESEARCH)

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ABSTRACT

The popularity of project-based learning (PBL) has led to a situation where engineering students take several group project courses at the same time. From a student perspective, this can generate considerable issues. Previous research has indicated that already single PBL courses can be challenging, especially time and task management-wise and intuitively overlapping PBL courses compound this complexity. As existing literature on this topic is relatively sparse, the goal of the present study is to examine what kind of student challenges simultaneous PBL courses generate, how students navigate those and what kind of additional learning can it foster. The results should help PBL course teachers to consider the impact of overlapping PBL courses from a student perspective and provide better support for them.

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1   INTRODUCTION

Teamworking capabilities as transferable skills are generally considered highly critical for engineers [1] and project-based learning is one method for integrating them into the curriculum [2]. While extensive research on project-based learning and teamwork-related aspects to it has been conducted, there are still many things we don't know [3].

As group projects have become more widely used in engineering education, students are more likely to find themselves in situations where they have to take part in several group projects at the same time. Research on organization science has indicated that multiteam membership, that is, being a member of several teams at the same time can either increase or decrease learning and productivity both on the individual and team levels depending on the context [4]. This implies that simultaneous group projects can be either an opportunity or a threat in the engineering education context, warranting the need for further research on the topic.

Against this backdrop, we examine in this study what kind of challenges and benefits simultaneous group projects generate for engineering students in terms of teamwork skills development. Our dataset consists of qualitative interviews among engineering students in a northern European university. The results suggest that taking several PBL courses simultaneously seems to generate a variety of social, interactional, cognitive, and emotional challenges, which students try to manage, especially with the help of productivity tools and strategies and planning ahead. Based on our observations, we suggest some interesting avenues for further research.

2   PROJECT-BASED LEARNING AS A CONCEPT

Project-based learning (PBL) refers to a method of learning where students work in groups on self-directed projects based on real-world challenges and participate in formulating the problems they aim to solve during the project themselves [2, 5]. PBL as a learning approach has received wide popularity in engineering education in the past decades. This is because PBL has been associated with such desirable outcomes as better employability of graduating students, higher learning motivation, and fewer drop-outs [6]. PBL also has been found to support learning generic practical skills necessary for work-life like project management and communication and collaboration skills [6]

Interdependencies between separate project courses have received scholarly attention mainly from the perspective of curriculum development. Since PBL as a learning method requires certain skills and understanding from the learners, there should be a clear structure and plan on how PBL-based courses are implemented in the curriculum and what are they focused on to enable students' longitudinal development [3]. One should have a meaningful mix of projects that focus on building more discipline-specific skills and knowledge through well-defined problems and those where more generic skills are learned and students work on more open-ended problems [7]

3 STUDENT CHALLENGES IN PBL

While in general students tend to enjoy PBL-based learning [5, 8], previous research has identified a number of potential challenges in PBL from the student perspective. Students can perceive learning less in terms of domain-specific engineering and science competencies compared to more traditional theory-based teaching [6]. This is perhaps because integrating in-depth natural science-related learning into group project-based teaching can be challenging [5].

A variety of specifically teamwork-related challenges have been observed in previous literature as well. Teams might have free-riders, those who lack time management skills, and people disinterested in the project topic which can cause challenges [8]. It is also possible that despite being technically assembled in teams, students don't actually work as a team. Instead, they might delegate work tasks and work on them in silos without actually collaborating, which can lead to work quality and organization issues [9]. To make sure that the team is organized, individual students might end up in a position where they perceive themselves as forced to take on a leadership role to activate those members who are less active and talkative than others [8]. Especially if the team is multidisciplinary, it can also be difficult for individuals to identify with others, which is problematic for team dynamics-wise [10].

Most studies related to PBL focus on the level of an individual course [3]. However, project courses do not take place in a vacuum. Instead often engineering curriculums are designed so that students take several courses at the same time and they of course have other personal commitments as well. In terms of the student experience, the implications of this are also important to understand. Some findings on the additional challenges that issues external to a specific team project course can cause are also found in existing research. Crichton et al [8] also noted in their research how working simultaneously with studying and other ongoing courses might cause challenges in terms of getting the team organized and performing well. Such other commitments and things like extracurricular activities or voluntary assignments easily lead to situations where finding a common time to work on the project is hard [11]. While these are important findings, for optimizing the student learning experience, further understanding of this topic would be beneficial.

4 MULTIPLE TEAM MEMBERSHIP AND ITS IMPLICATIONS FOR PBL

Multiple team membership refers to situations where an actor belongs to several project teams at the same time [4]. This topic has been recently gaining increasing attention in the field of organizational science since work in companies and other organizations are increasingly being organized around teams. Further, it has been shown that nowadays organizational members tend to belong to not only one but several teams at the same time [12, 13]. This can be challenging for the individual in a variety of ways. Especially in the beginning, it can place a considerable burden on one's psychological resources [14]. Further, cumulative workload from different

teams ends up exceeding individuals' capacity and it can lead to people prioritizing certain teams and neglecting others [15].

It would however be shortsighted to see multiple team membership only as a negative thing [4]. Being exposed to different types of work practices increases the likelihood of recognizing improvement or change potential in one's own practices [16], meaning that Individuals can learn something new and useful from each team they belong to [15]. It also can support individuals build their social networks, which is beneficial in many ways [14].

In summary, PBL as a method has been found particularly effective in terms of supporting learning teamwork and collaboration skills. Further, multiple team membership can support learning new things by being exposed to different types of teams, individuals, and practices. This raises the question of whether working simultaneously in different PBL-based courses in different teams could facilitate students' teamwork-related learning. Or would in such a setting the potential issues of multiple team membership end up leading to bad teamwork experiences and thus impeding learning?

Since many engineering students are already facing this situation during their studies where they need to participate in several PBL courses at the same time, further understanding on this topic would be important. With this in mind, the present study aims to explore this topic through the following research questions:

1. What kind of challenges do students that take several team-based PBL courses end up facing and how do they manage these challenges?

2. What kind of additional learning can simultaneous PBL courses provide for students?

5   METHODOLOGY

The research questions were addressed with a qualitative interview study in a Northern European university. The present paper is based on interviews with 9 engineering master's students who had participated in two or more temporally overlapping PBL courses during the same semester in the past 12 months. Informants were recruited by approaching students of two selected PBL courses, where it was known that many of the participants were likely to take other PBL courses at the same time. Participants were provided a 10 euro gift card as a reward for their participation.

The interviews were semi-structured in nature and lasted on average around 1h. The interview questions aimed to understand 1) what kind of groupwork-based PBL the informant had taken in the previous 6 months, 2) how did the projects unfold, 3) what kind of teamwork-related challenges did the informant experience as well as 4) what kind of additional challenges and learning did participating in multiple PBL courses at the same time bring to them.
For analysis, an inductive analysis process [17] was followed, drawing from the principles of grounded theory [18]. As such, analysis was mainly driven by patterns

observed in the empirical data, without trying to connect it immediately to existing theoretical frameworks. More specifically, transcripts of the interviews were first read through. After this, transcripts were thematically coded with three categories to identify parts of the interviews that were relevant to the research questions: 1) statements related to challenges generated by multiteam membership, 2) statements related to managing challenges of multiteam membership, and 3) statement related to learnings generated by multiteam membership. Next, statements for each code were open-coded to observe patterns in the data (for example: "No time to take care of wellbeing" or "Many meetings in a row"). In the final third step, open codes under each theme were examined and combined into broader abstract categories in the spirit of proceeding from open coding to axial coding [19]. At this point, findings were also compared to previous literature on the topic.

6 RESULTS

6.1 Challenges associated with multiple team membership

Informants reported a variety of different challenges related to multiple team membership from participating in several PBL courses at the same time. Drawing from Järvenoja et al [20] the challenges have been grouped into cognitive, emotional, and social & interactional challenges. Cognitive challenges refer to issues in understanding or being able to complete project tasks, emotional challenges to experiencing negative emotions and discomfort during the project, and social & interactional challenges to issues related to different working styles, communication, and context-related issues [20].

In terms of cognitive challenges, the most prevalent issue for the students was keeping track of what is happening in each team and what needs to be done for each course. One of the informants reported for example how just remembering which topics had already been addressed in which group was difficult:

"it takes your focus also away when you have multiple groups at the same time, you're not able to concentrate because you forget. What did you discuss in that group? What did you discuss here? So things get a little mixed up"

Informant #9

While similar issues can be associated with any kind of course, the problem was perceived to be amplified by the PBL setup, since in such courses more independent thinking and planning are needed as course tasks are less specific in terms of how they should be approached. This lack of big-picture understanding resulted also in small practical issues like forgetting meetings or missing small course deadlines.

Social and interactional challenges were reported by the informants as well. Because of other PBL courses and personal obligations, it was difficult to schedule meetings for discussing the project and working together. This led to situations where one had clashing meeting times between different projects making equal participation in everything difficult.

Even if it was possible to find distinct time slots for meetings of each team some problems remained. Often it meant that one could have meetings from different teams in a row, which was perceived as draining in itself. Having to switch contexts quickly from one project to the next amplified the cognitive challenges of staying on top of what is relevant for each project.

The constant context-switching also leads to a variety of emotional challenges, including feelings of being lost between the courses. Finding common meeting times required making personal compromises such as running from one meeting to the next or meeting late in the evening. This lead to sentiments that other team members don't care about your personal well-being or fail to recognize and appreciate the other commitments and responsibilities that one has. Enforcing personal limits in terms of contribution or participation because of the other pressures in turn created feelings of inadequacy and being left behind.

At the end of the project – we had this [another course] two weeks before the last presentation where we had to, attend the [other] classes. So we were meet me and my friend were a bit left over in the work and the progress done during those [final] two weeks.

Informant #1

6.2 Managing issues of multiple team membership

In terms of different ways to manage challenges caused by multiple team membership, three different types of strategies could be identified in the data.

First was prioritization. Some informants reported directing most of their effort into courses that they perceived to be the most meaningful to them. They still contributed to other courses, to respect the commitments they had made for the other team members and course in general. However, they reported not putting in the same amount of effort as in the courses they perceived most interesting. Also, some students prioritized those projects where they had been assigned a specific sole responsibility in the team compared to teams where their role was broader and more generalistic.

The second strategy was using productivity tools and techniques to combat especially cognitive challenges of multiple team membership. Some informants used to-do- and list applications like Trello to map their tasks for each course. Others conducted very diligent note-taking or separate Microsoft Teams channels to keep on track of what was discussed and happening in each team. To make getting quick answers from all team members and finding common meeting times easier, some reported using polls in mobile chat applications so that communication overhead would be reduced.

The third strategy was planning ahead and being organized. This could concretize for example in doing one's utmost to have meetings of different teams on different days to combat cognitive challenges. Some set internal deadlines for themselves that were tighter than official course deadlines to make sure personal workload was

more evenly distributed in cases where deadlines in different courses would have otherwise been overlapping.

There were also those students who did not really feel like multiple team membership was creating such problems that explicit managing efforts were needed. This was especially the case if the course structures of the simultaneously ongoing PBL courses were well aligned and for example, big assignment deadlines were not at the same time. Flexible teammates who didn't have their calendars completely full helped here also.

6.3 Additional learnings from multiple team membership

The main benefits informants perceived to gain from multiple team members in terms of additional learnings related to enhanced teamwork capabilities and recognizing one's capabilities in different roles.

In terms of teamwork capabilities, being able to simultaneously witness different leadership styles and dynamics in different teams helped form an understanding of what kind of leadership behaviors and structures support good performance and team dynamics. This included for example learning how to effectively delegate tasks and activate less active fellow students. Several informants also reported understanding now the importance of having a distinct leader in the group.

Many informants also noted learning to work in different kinds of roles and sharing responsibility. This included more functional roles like if one usually was responsible for doing presentations and giving these tasks to others to support the learning of others. Team dynamics-related roles were also mentioned, like switching from a follower role to more of a leadership role or from an active ideator role to one where one gathers ideas from others. Sometimes these role switchings were rooted in personal interest, but sometimes it was not particularly desired. One might end up being in the leader role mostly because nobody else was willing to take it and the team wasn't making good progress. Some informants also reported learning tenacity: having to work and finish things even in a situation where one doesn't enjoy the team or the project that much. Others reported learning nothing additional.

A few cases where individuals attempted to take good practices or learnings from one team to another were also presented in the data. One informant reported learning an effective feedback-providing method in one course and utilizing it in another struggling team successfully. Another described getting certain critical feedback in one course from her team members and because of that changed her behavior not only in the team that provided it but also in other teams she was working in concurrently. Third informant particularly enjoyed certain ideation methods in one PBL course, and utilizing them in another PBL course. There was also a case where a student learned an interesting analysis method in one course and tried to bring it to her other team, but the team rejected it which felt frustrating for the individual.

7 DISCUSSION

The present study contributes to the literature on student challenges in PBL education [3, 7]. More specifically the findings extend learnings from previous studies that have examined the student experience of PBL courses [8, 11] by going beyond the traditional single course focus and providing information on what kind of distinct challenges, benefits, and learnings participating in several PBL courses at the same time bring to students.

In terms of challenges that students face due to multiple team membership caused by simultaneous PBL courses informants reported different cognitive, social & interactional, and emotional challenges. Most prevalent cognitive challenges related to having a solid big-picture understanding of what is happening in which team and what are the most pressing tasks to do in each course. One observed way to solve this issue was by using productivity tools and techniques to stay on top of what needs to be done and what has been discussed in each team.

The main social and interactional challenge was the difficulty in finding meeting times as everybody in the team had also other courses (PBL and more traditional) and commitments that they needed to attend to too. This led to difficulties in putting equal effort in all the teams and having days full of meetings the latter of which led to further cognitive challenges. To combat this, students prioritized their participation in more interesting courses or just pushed through the challenges. The need to stretch one's capacity in turn created emotional challenges of not being able to take care of one's well-being and feelings of inadequacy.

These findings are in line with Crichton et al. [8] and Hussein [11] who observed how students in PBL courses can face scheduling challenges due to competing commitments, like other courses and working while studying. The present study's findings suggest that if those other commitments are other PBL courses, the situation can be particularly tricky since this scheduling-related overhead comes on top of cognitive challenges related to keeping track of what is happening and needs to be done in each distinct project. As such the results extend current scientific understanding by providing a more nuanced understanding of student challenges in simultaneous PBL courses and how those challenges can be managed.

In terms of learning, multiple team membership allowed students to witness different kinds of team constellations and dynamics. This led to recognizing leadership styles and practices one felt produced the best results. Interestingly, these leadership style-related observations seemed to usually favor the more traditional single-leader type of arrangement rather than shared leadership inside the team. This finding is interesting since in terms of team structure, none of the PBL courses that informants took suggested selecting a distinct project manager. On the contrary, one course that 8 of the 9 informants took, specifically tried to structurally enforce shared leadership by requiring rotating leadership-related roles inside the team.

Considering the fact that the need for traditional manager-led teams and organizations is being increasingly questioned in contemporary organizations [21],

this raises the question is it actually a good thing that students learn to prefer teams with traditional single-leader arrangements. However, considering the observed cognitive and social & contextual challenges related to simultaneous PBL course experiences, it does feel relatively intuitive that from the student perspective, teams where there is a clear and diligent leader are easier project contexts. With this in mind, it would be highly interesting to explore in future studies how shared leadership based team arrangements could be encouraged and fostered in contexts where students take several PBL courses at the same time.

The present study naturally has its limitations. Most obviously the dataset is relatively limited in terms of the amount of informants. However, the research project these findings are building on is still ongoing, and further interviews are planned. In addition, the dataset primarily consisted of informants from international backgrounds, specifically those of African, East Asian, and South Asian heritage. Several of these informants reported perceiving strong cultural differences in terms of how students from different countries approach studies and prioritization strategies related to simultaneous PBL courses. Thus, a study with a broader dataset in terms of the cultural background of informants could provide interesting additional observations related especially to strategies in managing multiple team membership. Finally, the present study looked at the phenomenon from the perspective of individual students. It could be particularly interesting to try to understand how PBL teams as collectives build practices and culture that fosters negotiating and compromising time and task management that alleviates challenges caused by individual commitments that each team member has.

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