Practical solutions to manage staff and student workloads in project-based learning courses

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ABSTRACT: Project-based learning (PBL) has many positive aspects in terms of encouraging critical thinking and teamwork skills, but this teaching style can have a high workload from both a staff and student point of view. Different methods to manage staff and student workload were reviewed and applied to a first year engineering course and the students were asked for feedback. To reduce staff workload, the mode of supervision and the number of supervising staff was reduced and peer assessment was utilised. Using supervisors who rotated around groups had a positive effect as it allowed the teams to get different perspectives; however, the reduced number of staff meant the students had less contact time with them. Peer assessment was very positive as it encouraged the students to be innovative. To minimise student workload, the staff allocated teams and topics to enable the students to start the project immediately, which the majority of the students appreciated.

Keywords: Engineering education, project-based learning, staff workload, student workload, teamwork

INTRODUCTION

Several international studies have found that today's engineering graduates lack teamwork and communication skills [1-3]; require a broader perspective in terms of social, environmental and economic issues [1][2]; and that while they have a good knowledge basis, they lack the ability to apply their knowledge in a practical way [2-4]. One technique to try and enhance these skills is to use project-based learning (PBL), which can encourage teamwork, allow for the context of projects to be emphasised, and show the students how to apply their engineering knowledge to real world problems [2].

Project-based learning typically involves small groups of students working together under the supervision of staff on a long-term project (i.e. one semester or more) [2]. This type of approach to teaching encourages the students to be more active in their learning, and promotes critical and proactive thinking [5], which are all key skills needed in graduate engineers.

While project-based learning has many advantages, there are also some criticisms of this approach. Two aspects, which are often a concern when implementing project-based learning, are the implications on staff workload and attaining the right balance in terms of student workload for a project-based learning course relative to a traditional course. This article aims to review practical solutions to manage both staff and student workloads when implementing project-based learning.

METHODOLOGY

This study started by reviewing the literature looking for ways to reduce student and staff workload without compromising the learning outcomes. Ideas from the literature review were then implemented in the Creative Solutions course. In order to evaluate the impact of these decisions, an anonymous questionnaire was distributed to all students in the course towards the end of the semester. The questionnaire was used to provide insights into the student perspectives when suggestions from the literature were implemented into the course.

The questionnaire was administered by an independent person who was not involved in teaching the class. The questionnaires were then sealed and not opened until all marks had been finalised to ensure that answers could not affect the student's grades. This research was reviewed and approved by the Massey University Human Ethics

Committee Southern B Application number 14/40. A total of 54 students completed the survey out of a class of 63 students giving a response rate of 86%. The questionnaire asked the students about their preferences in terms of supervision, peer assessment, team formation, topic allocation, and to compare the course with the other courses they were taking in the same semester. A five-point Likert scale was used for the comparison between courses. The wording of the questions asked is provided in the relevant section of the results and discussion section of the article.

RESULTS AND DISCUSSION

Staff Workload

While PBL has several advantages, there are also a few challenges. Of particular concern is the time-consuming nature of teaching in this way. It is often reported that when implementing PBL courses, it can have a significant impact on staff workload [6-10] with one teacher stating …*You do not know the workload involved if you are not on it* [7]. On top of the teaching workload, the organisation and administration has been reported to be very time consuming [9]. When designing a new PBL based course, there are several practical decisions, which need to be made regarding how the course will be set up and run. Two key decisions, which influence staff workload were identified and investigated further. These two decisions are the number of staff required for student supervision and the use of peer assessment to reduce the amount of marking to be undertaken by staff.

The number of staff supervising student groups can have a large impact on the overall staff workload. It is important that the supervisors allow the students to make their own decisions and that staff do not control any decisions made or influence the final outcome of the project. As described by Marin et al the students …*must be given the tools to succeed and the opportunity to fail* [11]. A good supervisor should know …*when to stand-back, and when to put on the brakes* [11].

In the Creative Solutions course, it was decided that the engineering students (12 groups) were supervised by two staff members who rotated around the groups, while the food technology students were supervised by one staff member (4 groups). This does mean that there is a reduced amount of supervision for the students and students needed to wait longer to see staff. While this does reduce staff workload, it could also have implications on the success of the student projects if inadequate supervision is provided.

Two questions were asked in the questionnaire regarding supervision. The first was whether the change in supervision from an allocated supervisor to rotating supervisors had an effect on their project. If the students answered yes, then they were asked to explain why. The second question asked if they would prefer an allocated supervisor, rotating supervisors or no preference. The change in supervision was found to have an impact on projects for approximately half of the students (Figure 1). Based on the comments given approximately half of these impacts were in a positive way and half were in a negative way as summarised in Figure 1.

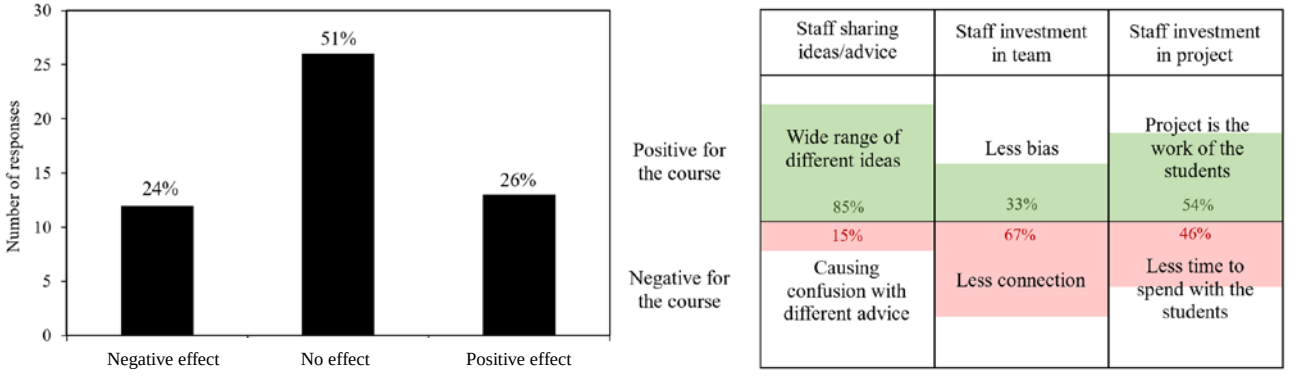

Figure 1: Summary of findings for the effect of changing supervision mode from an allocated supervisor to a rotating supervisor and analysis of comments.

In terms of project supervision, comments tended to cluster into three different themes each with their pros and cons. These are visually displayed in Figure 1. Staff sharing their ideas and advice can be positive, because it can spark other ideas and increase the range of solutions considered. Examples of comments are: *Having multiple supervisors allowed a new perspective and fresh advice*. *There was a positive variety of opinions and help removing any bias that can be present from a single supervisor. It worked much better for me this semester.* However, with more suggestions can come more confusion due to conflicting advice. Of the comments centred on the sharing of ideas/advice theme, the majority of comments were positive rather than negative (Figure 1) indicating a good balance had been struck in this course.

The second theme of comments centred on staff investment in the team (Figure 1). The positive comments suggested that roaming supervisors lead to less bias, but there were also many comments suggesting that there was less connection to their supervisors as they were not allocated in this course.

The final theme was staff investment in the project (Figure1). The positive aspect is that the project is the work of the students and not the supervisor, but the disadvantage is that the staff simply have less time with the students. Examples of comments are: *Supervisors had less input this semester. More decisions to be made by group members. It took longer to get help as the supervisors were fewer and had more people to see.*

Fewer supervisors reduced staff workload, but the students felt they needed to wait for longer periods to be seen. On reflection, in the future, this could be accounted for by setting other tasks to be completed during this time slot, so the students are not just sitting around waiting. The students had no clear preference in terms of supervision method as 41% would prefer an allocated staff member, 37% would prefer rotating staff and 22% had no preference. This indicates that either of these modes of supervision could be used without affecting students' perception of PBL.

Another method that was identified to reduce staff workload was to reconsider how the marking of assessments was conducted. The use of peer assessment, where one group assessed the work of another group, has been reported to have positive implications on staff workload [12]. Peer assessment has, however, been criticised for not being objective and students who know each other giving each other high marks, which leads to both positive and negative discrimination depending on how well the student is known [13]. However, it is also reported that students are more positive about its use if it is combined with another more objective method of assessment, and there are checks in place to make sure that students are assessing fairly [13].

The main assessment for Creative Solutions was a Web site, and it was decided to trial peer assessment to provide feedback on the Web site twice throughout the semester. The Web sites were assessed in terms of its visual impact, creativity and functionality. Race suggests that students informally peer assess as they are constantly looking at each other's work and judging their work and the work of others [14]. This means that while peer assessment reduces staff workload, it is likely to also have a positive impact on the students' work and the final outcome of the project. There is a clear message in the literature that the key to successful peer assessment is to have clear guidelines for the students and for the lecturer to have the right to adjust grades if necessary [15][16]. With this in mind, a clear marking rubric was used with descriptors explaining what was expected at each level along with a comments section for areas that were done well and areas that needed more work.

In the questionnaire, the students were asked if peer assessment had an impact on their work, and if they answered yes they were asked to explain why. The majority of students found peer assessment did, indeed, have an impact on their work (83%) and the vast majority of comments were positive. Common themes and examples of comments are given below:

- Gave them more ideas/inspiration (31%). Example comment: *It helped seeing the standard of other Web sites and getting feedback as it gave us more ideas and inspiration to improve our own Web site*.
- Improved the standard of their work (21%). Example comment: *By checking the feedback from other teams, we successfully generated better ideas than before*.
- Helped them reflect critically on their own work (13%). Example comment: *Critiquing others ideas caused me to critique our work more*.
- Improved visual appeal of their work (13%). Example comment: *It gave insights into the quality of Web sites and gave an opportunity to see other people's ideas/ways of being more visually communicative*.

While it is important to balance peer assessment with staff evaluation, the use of peer assessment had very positive aspects in terms of generating some healthy competition between groups and encouraging innovation. Many PBL courses could incorporate peer assessment and, while this had the advantage of reducing staff workload, it was also found to have a positive impact on the students' work.

Student Workload

As well as the time commitment from staff in PBL courses, student workload has also been reported to be an issue [2][13][17-19]. Studies have found that while students find PBL courses time consuming, they do not always see this as negative as they enjoy the experience [19] and in one study, while they described their workload as *heavy*, they also requested greater access to workshops and laboratories outside of class time [19]. Based on the author's previous PBL experience, it was felt that many student projects experience a lag in progress at the start due to indecision. This then causes the rest of the project to be rushed and a heavy workload, especially when the first assessment is due. Based on this observation, the two key practical decisions to focus on were team formation and topic definition. It was expected that if these decisions could be made quickly, the project could start immediately and this would reduce overall student workload.

Several team formation techniques have been reported in the literature including forming teams based on ability, interest at random and allowing the students to choose their own team members [20]. Some studies have found that students prefer to form their own teams [21]; however, other researchers have reported that when students form their own teams, they tend to choose people they already know, and it can be challenging for students to be critical of their friends work and performance within the team [22]. Oakley et al also noted that when students form their own teams, the stronger

students tend to cluster together, and have a tendency to allocate tasks to individuals and work separately rather than working as a team [23]. This means that allowing strong students to work together not only means that the weaker students will struggle, but also that it will not foster teamwork skills to be developed by the stronger students.

According to Spoelstra et al, there are three key variables, which need to be considered when forming teams: knowledge, personality and preferences [24]. It has been suggested that a questionnaire is circulated to gain knowledge on interests, ethnicity, gender and other information [23]. This can then be collated and used to form the best combination of groups based on this information; however, this does require additional work for staff and students.

For the Creative Solutions course, the teams were allocated at random from within their majors. By grouping the students by major, this was hoped that students would be in a group of students which shared common interests. This allowed the students to start their project immediately on the first day of class.

The students were asked in the questionnaire whether they would prefer to be put into teams or choose their own team. Feedback from the students showed there was a clear preference for students to be allocated into teams by staff (75%) rather than forming their own teams (25%).

The element of choice within PBL has been reported to be important as it enhances student interest and perceived value [25]. In fact, Bell stated that *The element of choice is crucial for students' success* [26]. One significant choice that the students can be involved in is the choice of topic for their project and this choice in particular has been reported as being beneficial as it increases student engagement [27].

While it would be ideal to give the students the option to choose a topic, it can result in popular topics dominating and an extended amount of time being spent on this decision. Another phenomenon, which can occur is that the students begin on one topic, but then change their mind due to a difficulty in finding information. This was found to occur by ChanLin [28]. To speed up the process, the topics were allocated to each group of students on the first day of the course. These decisions meant that the students were given no choice in terms of their group or their topic.

In the questionnaire, the students were then asked if they would prefer to choose their own topic or if they preferred to be allocated a topic. In terms of topic allocation, the students views were split with 51% wanting to choose their topic and 49% want to be allocated a topic. While literature suggests choice is important to ensure students are interested and engaged in the project [25-27], the decision to allocate teams and topics seems to be appreciated by most students, and there is no clear preference for either of these decisions to be left to the students. These findings mean that there were no obvious disadvantages to forming teams and defining topics for the students. One student commented that: *I like being assigned groups and topics, because it keeps the focus on the project rather than trying to pick people to be in a group with and wasting time trying to decide on a topic*.

Unless decision making is a learning outcome of the course, the project can get underway much more rapidly if this is adopted in other PBL courses. If one choice was to be given to the students, these results suggest that the students would prefer to choose their topic rather than their team.

Comparison of PBL to Traditionally taught Courses

The students were asked to compare the project-based course to the other more traditional courses in terms of difficulty, engineering focus, time commitment and how enjoyable they were. Results are shown in Figure 2.

In terms of difficulty, there was a wide distribution of answers with the majority of the answers being neutral (Figure 2a). On average, slightly more students found the project more difficult than the other courses they were taking (average score: 3.3; standard deviation 0.9), which might be related to the wide range of skills they needed to develop including teamwork and communication.

Students found the project course had more of an engineering focus (Figure 2b, average score: 3.9; standard deviation 0.9), which is probably due to the fundamental nature of the other courses (mathematics, physics, chemistry and computing) compared to the applied nature of the project. Most students found that the project course took more time than other courses (Figure 2c, average score: 3.9; standard deviation 0.9), perhaps due to the need to work as a team and needing to have regular meetings outside of class time. In terms of their enjoyment, the students were neutral or slightly positive (Figure 2d, average score: 3.1; standard deviation 0.8).

There were a few students who did not enjoy the course, which could be related to the amount of time they spent doing the course. A statistically significant correlation was found between the time spent on the course and how enjoyable the course was. Those that found it the least enjoyable also said that it took a lot of time (p value 0.03). Sener reported that …*students spend more time on these projects than they do for exams and other work but do not complain* [29]. However, the findings from this study have shown that this is not always the case. This suggests that even when project-based learning courses are designed to try and reduce student workload there are still further adjustments to student workload required.

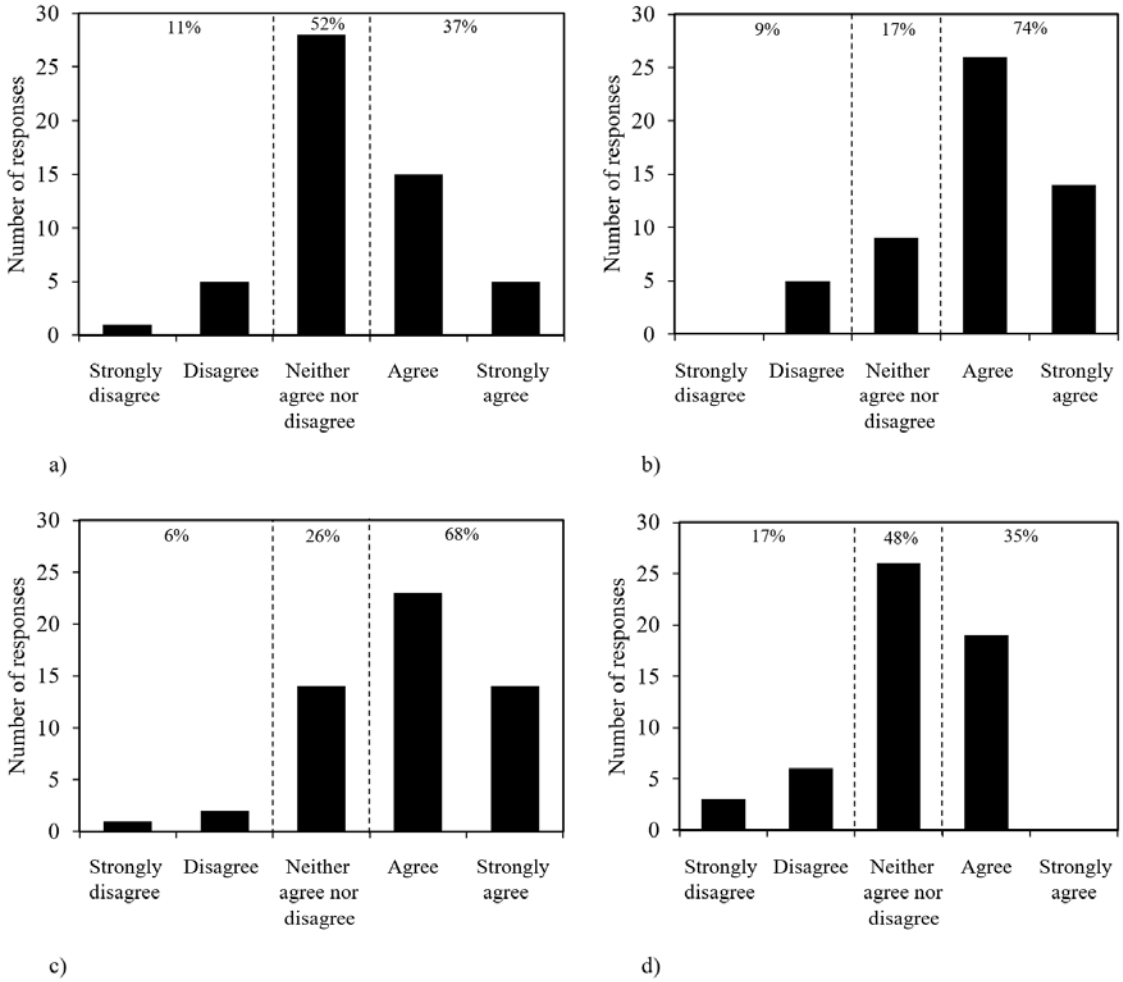

Figure 2: Responses comparing project courses to traditional courses: a) project courses more difficult than others; b) project courses had more engineering focus than others; c) project-based courses more time consuming than others; and d) project courses more enjoyable than others.

CONCLUSIONS

In terms of supervision, the students found that fewer staff who rotated around the room rather than being allocated to specific teams meant that the teams could get different perspectives and fresh ideas from different staff members, which was seen as having a positive impact on their projects.

Peer assessment reduced staff workload and also was beneficial for the students as they reported that it encouraged creativity and innovation, and a healthy level of competition between different groups in the class.

Allocating students into their groups and defining their project allowed the students to start work immediately. This reduced their workload as it meant they had at least one extra week of effective class time as there were no delays at the start of the project.

Overall, the strategies developed to allow the project to get underway quickly and to minimise staff workload have been successful without negatively impacting on students' work, and many of the actions taken have in fact had a positive effect on the course and these changes could easily be applied to other project-based learning courses.

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BIOGRAPHY

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