

Development of Project Management Skills through Collaborative Learning

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BACKGROUND

The engineering students are expected to develop and hone a continuously expanding set of technical and non-technical skills. These include team working, communication, negotiation, project management, problem solving and other skills. Engineering programmes use variety of traditional and non-traditional learning methodologies to encourage the development of the necessary skills. These include project based, active and peer assisted learning.

PURPOSE

This research is aimed at assessing the effectiveness of using collaborative learning between semester 1 and 4 engineering students. By acting as Project Managers, the Semester 4 students are expected to develop real life project management skills while the semester 1 students are benefiting from the experience and mentorship of the more senior students.

DESIGN/METHOD

To assess the effectiveness of the use of collaborative learning, two surveys are designed and administered to both the semester 1 and 4 students respectively.

RESULTS

The results show that both group of students found the experience to be enjoyable and useful. Both groups of students have interest in the success of the project and this created a dynamic learning environment.

CONCLUSIONS

Collaborative learning can be a powerful learning tool that benefits all the collaborating students. When the design of the collaborative activity encompasses two or more modules, communication and alignment between the coordinators is very important.

KEYWORDS

Collaborative learning, project-based learning, project management

Introduction

Besides the technical skills, engineering students are expected to develop and hone team working, communication, business, project management and problem-solving skills. To effectively develop these skills, engineering programmes use variety of methodologies. Active learning is one of the widely reported methodologies in the literature and it includes techniques such as cooperative learning, collaborative learning and problem-based learning (Prince 2004). Getting students to assist each other in their studies, such as the case of peer tutoring, where more advanced learners help the less advanced one, is also reported to benefit both the tutors and tutees (Saunders 1992). When compared to Problem-Based learning, Project-Based learning is reported to be more appropriate in the engineering education context (Mills & Treagust 2003). Currently the Project-Based learning is adopted, to a variety of extents, in a number of European, American and Australian universities (Neal et al 2007). The School of Engineering at Taylor's University (Malaysia) adopts a project-based approach where in each semester, students from the different engineering programmes are required to take a project-based module where they work in multidisciplinary teams to conceive, design, implement and operate an engineering system (Al-Atabi and Mahdi 2011). Besides the project-based modules, the programme structure includes other business and management related modules to ensure a well-balanced exposure both to technical and non-technical subject matter. These modules are outlined in Table 1.

This paper reports on using collaborative learning integrating the delivery and assessment of “Engineering Design and Communication” offered at semester 1 and “Managing Projects for Success” offered at semester 4. Twenty of the semester 4 students are offered the opportunity to be the project managers to the twenty 5 students teams at semester 1. The study aims at evaluating the effectiveness of this integration of delivery in improving the overall students learning experience.

Table 1: Project-Based and non-engineering modules offered.

Semester	Module Name	Credit Hours
1	Engineering Design and Communication	3
2	Engineering Design and Ergonomics	3
3	Multidisciplinary Engineering Design	3
4	Engineering Design and Innovation	3
	Managing Projects for Success	3
5	Engineering Group Project1	3
6	Engineering Group Project1	3
	Business Skills for Engineers	3
7,8	Final Year Project	12

Modules Description

Engineering Design and Communication

Taylor's University runs two 14-week semesters per year and students need 8 semesters to complete their respective engineering programme. Engineering Design and Communication is a three credit hour module offered to all semester 1 engineering students. Students teams

are formed randomly by the module coordinator, the only requirement is that the team should have at least 1 student of each engineering programme, namely, chemical, electrical & electronic and mechanical engineering.

Upon successful completion of this module, a student is expected to be able to

1. Explain the social, cultural, global, ethical and environmental responsibilities of a professional engineer.
2. Understand the importance of effective team working and be able to adopt team working strategies.
3. Use reverse engineering to infer how a given device works.
4. Describe the design process, including the concept of design constraints and the iterative nature of design, and recognise design in other disciplines.
5. Critique different design ideas, comparing and evaluating them.
6. Produce clear and accurate sketches and drawings (both manual and computer generated).
7. Write effective technical reports and updated logbooks.
8. Use appropriate visual communication techniques to communicate concepts and ideas.

The centrepiece of this module is a Grand Challenge design competition in which teams of 5 students are required to conceive, design, build and race solar model boats. The teams are required to race their boats across a 50 m long water channel. The boats should fit within a box of 60cm x 60cm x 60cm dimensions and be solely operated by solar energy with zero stored energy at the beginning of the race. The cost of building each boat should not exceed RM 250. To give the students the opportunity to manage a budget, the university is providing the funds to build the boats. The students will need to maintain a basic set of accounts and receipts for the purpose of project closure.

Managing Projects for Success

In order to provide the engineering students with a professional project management experience, all students are required to take “Managing Projects for Success”, a three credit hour offered during semester 4.

Upon completing this module, a successful student should be able to

1. Define what a successful project is.
2. Explain project management process groups.
3. Apply techniques to manage and balance scope, schedule, cost, resources and other aspects of a project.
4. Evaluate the success or failure of a project.

The module is assessed through a final exam (40%) and continuous assignments (60%). The students need to manage a project using the tools and techniques introduced during theory classes. The students are offered a choice of either managing a semester 1 solar boat team or work in groups of 3 to manage another project assigned by the module coordinator. Students who wish to be chosen as Project Manager are needed to “apply” for the position by writing to the module coordinator. The job description of a project manager is shown in Figure 1. As the solar boat is a competition, the Project Managers need to sign a non-disclosure-agreement NDA to ensure confidentiality of the design idea.

Collaborative Learning Organisation

After completing the selection process of the Project Managers (Semester 4 students), they were assigned to different teams working on building their boats (Semester 1 students). The performance of the Project Managers is assessed by the module coordinator of the Managing Projects for Success module while the team working on the solar boat are assessed by the module coordinator of the Engineering Design and Communication module

coordinator. Clearly, both the Project Managers and the Team members have vested interest in getting the project to succeed and this created a dynamic working environment.

Project Manager Job Description

Job Title
Project Manager

Qualifications and Competencies

- Registered for Managing Projects for Success module
- Dynamic and resourceful
- Team player and results driven
- Good negotiation and communication skills

Job Description

The successful candidate will lead a team of first semester students to successfully complete their Design project. He (she) is responsible for the overall project management including initiation, planning, execution, control, and closing the project in a manner consistent with the best project management practices to ensure the achievement of the project goals and objectives. The Project Manager will report to the Module Coordinator of “ENG1513 - Engineering Design and Communication”

Main Job Tasks and Responsibilities

- Lead the initiation, planning, execution, control and closure of project
- Facilitate the definition of project scope, goals and deliverables
- Define project tasks and resource requirements
- Develop project plans
- Regularly meet project team and keep a logged record of all discussions
- Manage project budget and resources allocation
- Plan and schedule project timelines
- Track project deliverables using appropriate tools
- Motivate and support to project team
- Monitor and report on progress of the project to Module Coordinator
- Implement and manage project changes and interventions to achieve project outputs
- Evaluate project results and outcomes
- Motivate and inspire team members
- Resolve any conflict that may arise in the team

Figure 1: Project Manager job description

Methodology

In order to assess the value added by introducing the collaborative learning, two surveys were designed and administered to both the teams and project managers. The survey were designed to investigate how useful and enjoyable the collaborative learning was, how useful it was to be have a project manger or to work as one, and how do the students assess their role in the project dynamics. To encourage the students to respond in an honest manner, it was made very clear to them that the surveys will not be used as an assessment tool. They responded to the surveys anonymously and independently as teams members' responses were not crosschecked with those of their peers or their project manager. The students were encouraged to complete the surveys and the response rate was around 90%. The surveys

required the students to indicate their responses on a 5 point Likert Scale where 1 indicates strong disagreement and 5 indicates strong agreement. The surveys for team members and project managers are shown in Figures 3 and 4 respectively.

Results and Discussion

The Grand Challenge solar boat competition was concluded successfully and some of the images taken during the competition are shown in Figure 2. In order to assess the levels of learning and satisfaction among the students, two surveys were designed and administered to the Project Managers and the team members. The surveys and the results for the team members and the Project Managers are given in Figures 3 and 4 respectively. The results of the study indicate that the students taking “Engineering Design and Communication” found having a Project Manager to be useful as the Project Manager helped motivating the team, keep the project on track and help resolve conflicts not to mention helping with issues that are technical in nature. On the other hand the Project Managers found managing a real project with a real timeline and a real project to be challenging yet satisfying. All students found the process to be generally very enjoyable.

Among the team members, only 8% of the respondent strongly agreed and 40% agreed to the statement that the lecturer provided adequate support. Project managers on the other hand were more positive towards the support given by the lecturer with 28% strongly agreeing and 17% agreeing to the statement that the lecture’s support was adequate. This may be attributed to the higher level of maturity among the senior students as well as their longer experience with project-based learning.

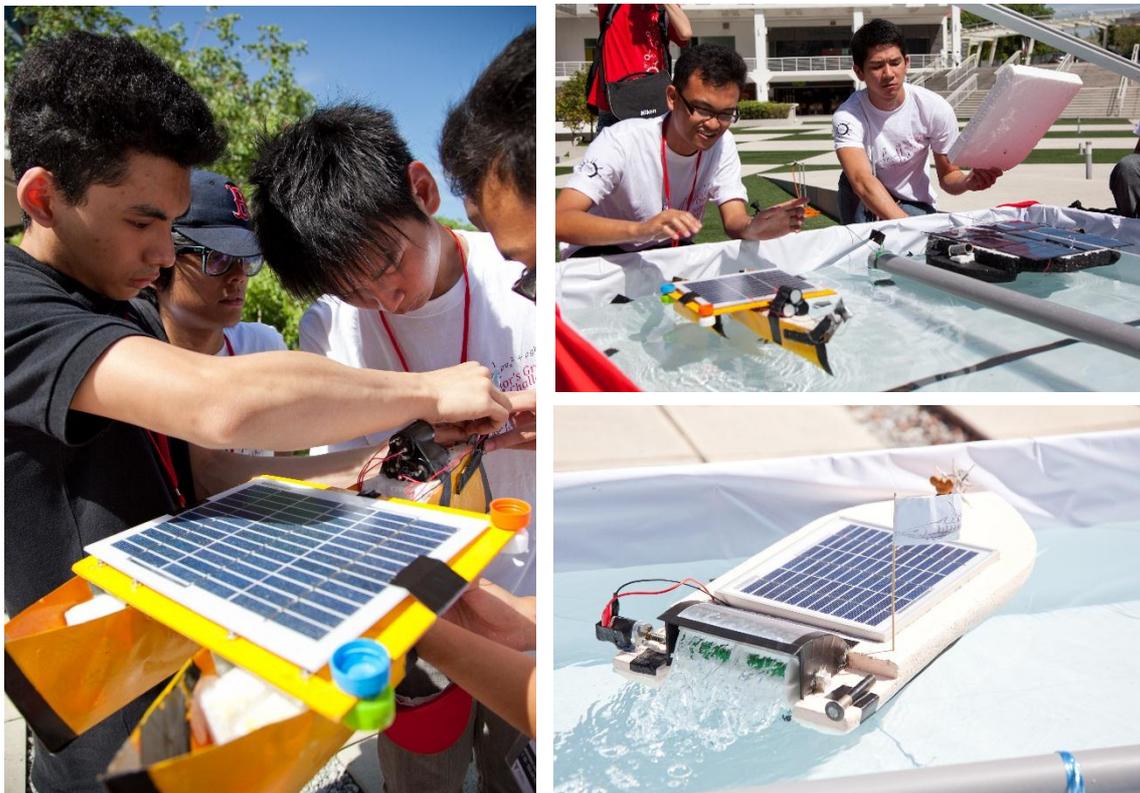


Figure 2: Images from the competition day

All the teams managed to successfully achieve the objectives of the project. This is clearly reflected in the responses of team members (to statement 4 in the team members survey) and the project managers (to statement 3 in the project managers survey). Both statements attracted the most positive responses of “agree” and “strongly agree”. From previous

experiences, it is a rare occurrence for all teams to achieve the objectives successfully. However, it is premature to attribute this to the use of project managers and more work needs to be done to investigate this.

All the students did well in the overall “Managing Projects for Success” module results, including the final written exam.

Running these two modules simultaneously required continuous alignment and communication between the two module coordinators and teaching teams. It also mandated rigorous monitoring of projects’ progress and project managers and teams performance to weed any conflict as early as possible.

Conclusions

In an attempt to give engineering students registered for “Managing Projects for Success” an authentic project management experience through handling a real project with a real budget, timeline and project team, the students are assigned to projects related to run tasks associated with the engineering fair and leading junior students teams working on building solar boats. The students generally found the experience to be challenging, satisfying and enjoyable. The teams that were managed by the Project Managers also expressed their satisfaction with the process

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Team Members Survey

1. The objectives of the Grand Challenge were communicated clearly to my team.
2. Support given, by lecturer, was adequate.
3. The budget allocated by the School was sufficient.
4. My team managed to achieve the objectives of the Grand Challenge.
5. I contributed very positively to the team effort.
6. In general, my team members contributed positively to the team effort.
7. I personally found the Grand Challenge meaningful and enjoyable.
8. I was able to manage my time effectively while working on the project.
9. Working on the project help me improve my communication skills.
10. Working on the project help me improve my team work skills.
11. Having a Project Manager was very helpful.
12. The Project Manager played an important role in completing our project successfully.
13. The Project Manager communicated with my team clearly.
14. The Project Manager met with my team frequently.
15. The Project Manager monitored our progress and checked our Gantt chart periodically.
16. The Project Manager requested written progress reports from my team.
17. The Project Manager put effort in motivating my team.
18. The Project Manager supported my team on technical (design) related aspects sharing and proposing ideas.
19. The Project Manager help us resolve conflict within the team (answer only if applicable)

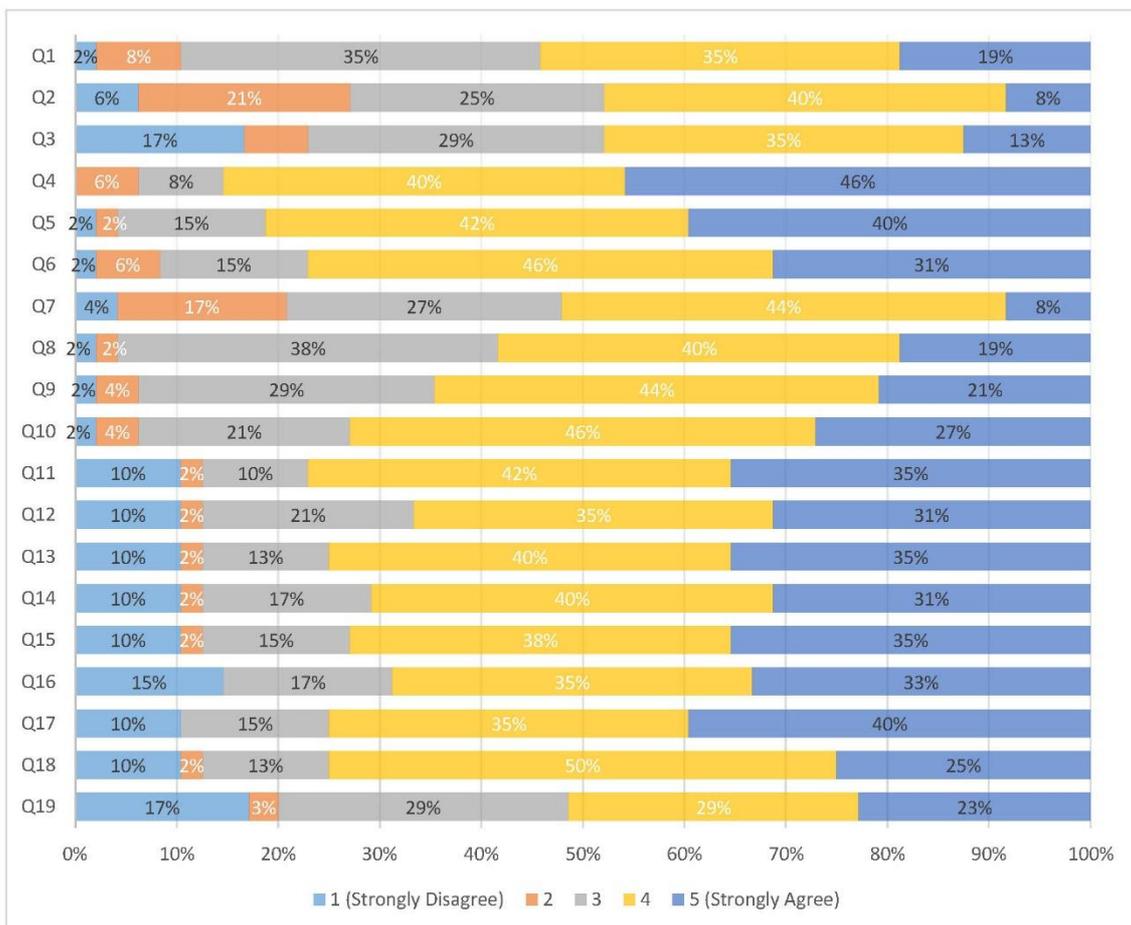


Figure 3: Team members survey results

Project Managers Survey

1. My role as a Project Manager was communicated clearly to me at the beginning of the semester.
2. The support given to me, by the lecturer, throughout the semester was adequate.
3. My team managed to achieve the objectives of the Grand Challenge.
4. I played an important role in the team success.
5. In general, my team members contributed positively to the team effort.
6. I personally found the Grand Challenge meaningful and enjoyable.
7. I was able to manage my time effectively while working on the project.
8. Working on the project help me improve my communication skills.
9. Working on the project help me improve my leadership skills.
10. I communicated with my team clearly and regularly.
11. I met with my team frequently.
12. I monitored the project progress and checked the Gantt chart periodically.
13. I requested written progress reports from my team.
14. I put effort in motivating my team.
15. I supported my team on technical (design) related aspects sharing and proposing technical ideas.
16. I help resolve conflict within the team (answer only if applicable)

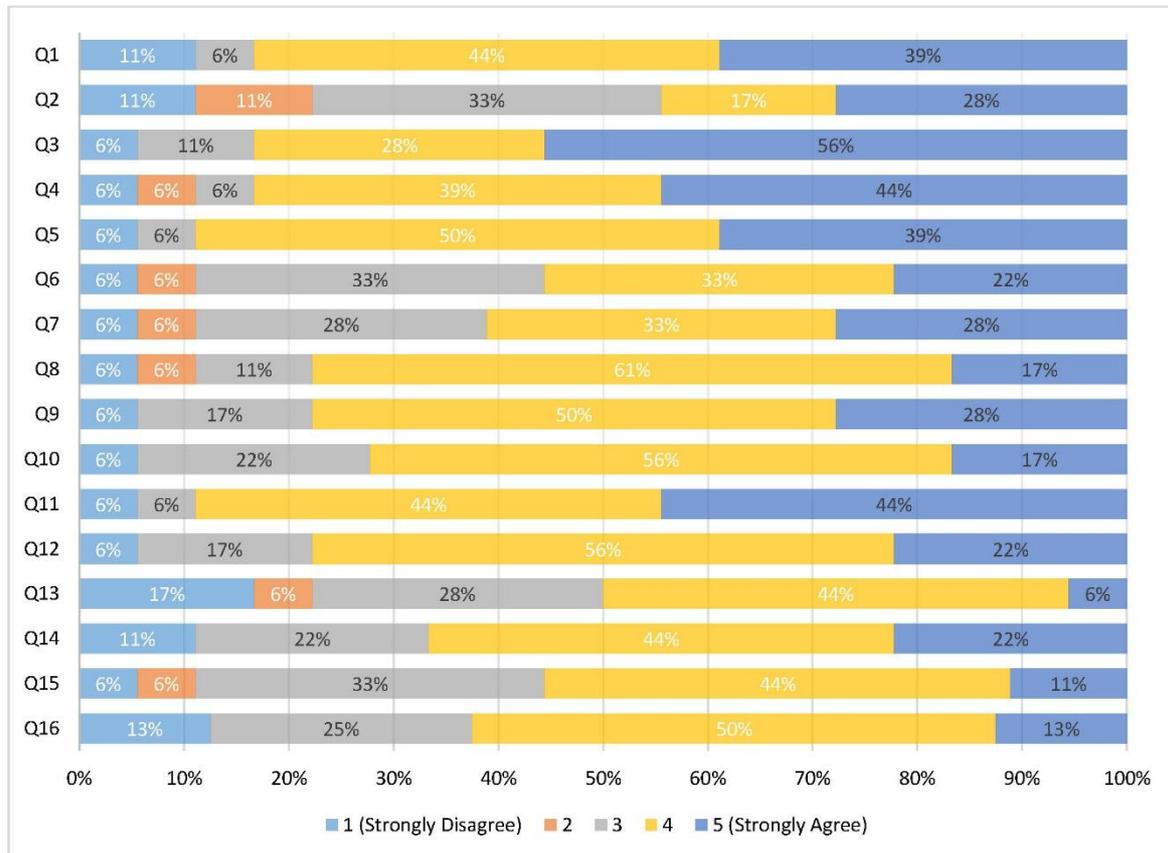


Figure 4: Project Managers survey results

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