

# **THE EFFECTIVENESS OF TEAM PROJECT WORK FOR DISTANCE EDUCATION STUDENTS**

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## **ABSTRACT**

Project Based Learning (PBL) has been recently introduced to a final year structural design course at the University of Southern Queensland (USQ) and one assessable requirement associated with the project is teamwork. Unfortunately, when teamwork was first introduced to the course in 2010, most students chose to work individually. The project was re-designed and teamwork was made compulsory when the course was offered in 2011. In order to maximise the benefit of teamwork, a questionnaire was sent to students to identify their perceived strengths and weaknesses related to the design project before it commenced. The distance education team members were then matched up based on the questionnaire. A second questionnaire was sent to students after the project was completed to check if students valued teamwork more compared with the responses from the previous year. This paper will discuss the analysis of student feedback before and after the project, compare the outcomes between distance education (external) and on-campus students and explore potential means of promoting teamwork to distance students.

## **KEYWORDS**

Project-based learning, distance education, teamwork, structural engineering, design.

## **INTRODUCTION**

It is widely recognised that to be successful in today's workplace, a high level of teamwork skills is necessary. In addition, globalisation and rapidly changing technologies have made online collaboration a common practice in engineering firms. Therefore, providing students with online team collaboration experiences that they can later apply in the engineering workplace becomes increasingly important [1].

Project Based Learning (PBL) has been recently introduced to a final year structural design course at the University of Southern Queensland (USQ) and one assessable requirement

associated with the project is teamwork. USQ is one of Australia's leading regional universities and is noted for excellence in distance education [2]. There are approximately 3000 students enrolled in the Faculty of Engineering and Surveying programs and around 80% of these students are distance education students. Therefore, both on-campus and distance learning students jointly participate in all course activities in hybrid modes.

This study continues an investigation that began in 2010, when teamwork was first introduced for the design project assessment component of a final year Structural Engineering course taught by the first author. In 2010 the project was arranged in such a way that students were encouraged to work in pairs, but students did have the option to choose to work individually if they preferred. However, if they chose to work individually then the overall work required was certainly greater than 50% of a project done as a pair, even though some reduction in project tasks was allowed for an individual. After the projects were submitted, it was found that most students chose to work individually. An analysis was then conducted to explore why students chose not to work in teams, and particularly to determine the barriers that prevented it for distance education students [3].

Following on from the unsuccessful experience in 2010, the teamwork project was re-designed following similar stages as suggested in the framework developed by Tuckman [4] and using strategies suggested by Johnson et al. [5] on virtual team work. Teamwork in the design project was made compulsory when the course was offered in 2011. In order to maximise the benefit of teamwork, a questionnaire was sent to students to identify their perceived strengths and weaknesses in relation to both technical content and teamwork before the project. For the distance education students the project pairs were selected by the lecturer based on matching the questionnaire feedback, regardless of their past academic achievement. On-campus students were allowed to form their own pairs regardless of the questionnaire outcomes. A second questionnaire was sent to students after the project was completed to check if students valued teamwork more compared with the previous year. This paper will focus on the learning outcomes of the students, the effect of team forming, analyse the student feedback before and after the project and explore potential means of promoting teamwork to distance students.

## **BACKGROUND AND PREVIOUS WORK**

### ***Previous research and conceptual framework***

The fast development of IT technology has resulted in the online collaboration of engineers that are located in different places as a common practice in the commercial world. Teams are now able to communicate, collaborate, and perform tasks irrespective of time and space. Virtual learning teams are also being used in tertiary education as well as corporate training programs in an attempt to enhance collaboration and cooperative learning experiences [5]. In order to provide students with online collaboration experiences, Barchilon and Baren [6] developed an online engineering design project in which undergraduate students from two universities collaborated. The qualitative evaluation of the project found that the project was successful in making the students aware of the challenges and complexities of online communication. However, previous research suggested that face-to-face teams are more effective. McGrath and Hollingshead [7] compared the performance of computer-assisted groups and face-to-face groups. They found that computer-assisted groups tended to have fewer interactions and less information exchange among members.

In order to improve the effectiveness of virtual learning teams, Johnson et. al. [5] have developed a few strategies. They suggested that the tasks and objectives for online team projects should be clear and simple; project timelines should be reasonable to give enough

time for students to adjust themselves to work in a virtual environment. Proper training is also essential at the beginning of the project.

Although many researchers have investigated group selection process, Tuckman's [4] framework from over thirty years ago is still widely adopted. The four sequential phases of (i) forming, (ii) storming, (iii) norming and (iv) performing that Tuckman proposed have been adopted by many studies. Each stage of Tuckman's model is an essential step for a team and, much like other linear models, if the first step is not accomplished, the latter stages will not be successful [5]. However, research also found that for virtual learning teams, the storming phase may be omitted [5]. More recent research has been conducted by Reisslein, Seeling & Reisslein [1] on virtual learning teams within a formal online education context compared with hybrid courses (i.e. courses that include students undertaking both on-line learning and face to face learning). This paper will attempt to examine the factors that affect the class activities for a hybrid course where a team project was introduced.

### **Course overview and 2010 results regarding team work**

*Structural Design II* is a final year design course at USQ that represents the end point of many other courses including: *Engineering Statics*, *Stress Analysis*, *Structural Design I*, *Concrete Structures* and *Structural Analysis*. The course aims to apply the knowledge and skills developed in these earlier courses to the design of some standard structural systems and buildings.

About 60 students enrol in this course annually and over 80% of them are studying externally. External students who are normally working para-professionals with a diverse background in terms of age and industry experience. The steel design unit makes up 50% of the course and the design project was first introduced when the first author took over the course in 2009. In that year, the steel design project was individual and a teamwork approach was first introduced in 2010 in order to reflect the requirement of graduate attributes such as:

- The ability to contribute effectively as a member of a team;
- The ability to communicate effectively; and
- Organisation and time management skills.

All students at USQ undertake a core series of courses referred to as *Problem Solving* courses where teamwork is compulsory. In contrast to these courses, the steel design project in *Structural Design II* was originally arranged in such a way that students were encouraged to work in pairs, but students did have the option to choose to work individually if they preferred [3]. When the design project was given to students at the beginning of the course, the idea of teamwork was welcomed and the first author was confident that most students would choose to work in teams, given their previous exposure to this in the *Problem Solving* courses and also because of the potential for reduced workload. However, during the project consultation times with on-campus students, it was found that most of them did not intend to submit the project as part of a pair, even though some of them were actually working together to complete the project. After the projects were submitted, it was found that only one report of 15 submitted (6.7%) was produced by a pair of on-campus students whereas the number increased to 15.4% for distance learning students [3]. Some students assumed that they were allowed to work together as a pair, however, they were under the mistaken impression that they were required to submit individual report, a clear indication that the concept of the team work was being misunderstood. Therefore, one of the issues that contributed to the failure of team work for on-campus students was clearly that the instructions and explanations for students were insufficient. For the 2011 delivery of the course the team project was re-designed based on Tuckman's framework [4] and the strategies suggested by Johnson et al. [5], as discussed in the following section.

## **METHODOLOGY ADOPTED FOR THE TEAM DESIGN PROJECT**

### ***Participants***

The current study considered a hybrid course where the on-campus students attend the lectures on campus and the distance students do not come to campus but receive all information through the course webpage over the internet. Both groups of students participated in the same team design project, but no teams included a mix of on-campus and distance education students and thus the performance of each group was able to be analysed and compared.

### ***Team forming***

In order to maximise the benefit of teamwork, the concepts and advantages of team work were introduced to the students before the project implementation through the powerpoint presentation. A questionnaire was sent to students to enable them to assess their own strengths and weaknesses related to the design project and teamwork by answering the following four questions:

- What are your strengths in structural analysis/design area?
- What are your weaknesses in structural analysis/design area?
- What are the most important technical concepts/communication/time management skills you want to learn from others through this design project?
- What knowledge and skills could you share with others?

Due to the small number of students who enrolled in the course (around 60) and lack of positive teamwork experience of the students, the projects were undertaken in pairs of students rather than small groups. For the distance education students the project pairs were selected by the lecturer based on matching the questionnaire feedback, regardless of the students' past academic achievement. However, for on-campus students, the pairs were formed by the students' own choice (they all know each other well and the working pairs have been formed naturally previous taking this course).

### ***Project Implementation***

It should be mentioned here that since USQ is the leading Australian university for distance education, each course offered by USQ is supported with the most advanced online learning technologies. All external students enrolled in this final year course have gained extensive online learning experiences through their previous studies at USQ.

After the pairs were allocated by the lecturer and the students agreed to the allocations, the students were given 5 weeks to submit the project. During this period of time, the first author regularly monitored the electronic exchange between the pairs and emailed to each pair regarding the progress of their project. For on campus students, this consultation was conducted before and after the normal lectures and during a specified consultation time. A few issues were resolved in the first two weeks and all pairs seemed to progress well after that. Peer assessments were collected from each student when the project was due. This was done by each student to email his/her assessment form to the lecturer and it was confidential.

## **RESULTS AND DISCUSSION**

In this research, the effectiveness of the group learning through team forming and students' perceptions are assessed. The ideal outcome of team learning would be each member sharing his/her strengths with the other team member to achieve an outcome that is superior to one that can be achieved alone. The team was formed based on this idea for all external students and the outcomes are discussed in the following sections.

### ***Students' response on team forming***

All external students were assigned to a virtual pair based on the questionnaire which was submitted by each student through an online system within the course homepage. They were informed online of the partner's name and email address as part of the feedback to their questionnaire submission. The external students' response on group forming is shown in Figure 1, where 90% of students were happy with the lecturer's matching up of the team members and kept working together until the reports were submitted. Three students in total ended up working alone on their projects for reasons that will be explained in a later section. The student feedback obtained from their peer assessment and the course experience questionnaire completed after the project was submitted showed that nearly all students were satisfied with the performance of their partner and recommended that the same mark should be awarded to each student in the pair. Only one student claimed that the lecturer should mark the sections he was responsible for separately as he believed he did a better job than his partner.

This result is significantly different to 2010 result where only 6.7% on-campus students and 15.4% distance learning students respectively were happy with the idea of teamwork [3]. This study reveals that if the reason for requiring students to work in teams for projects is made explicit and placed in the industry context relevant to the task, team work could be successful.

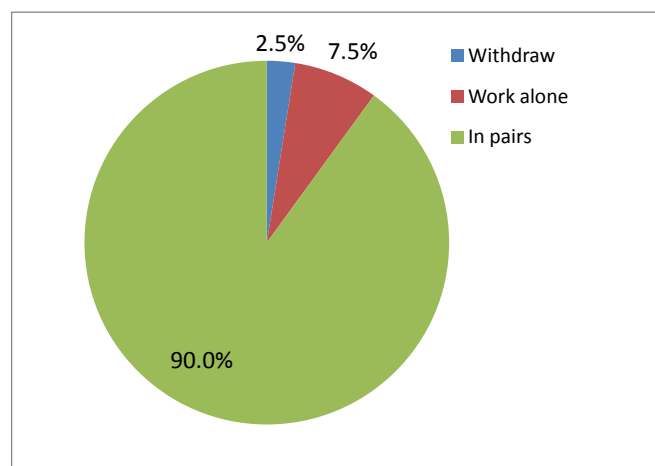


Figure 1: External students' response on group forming

### ***Team norming and trust***

The team norming stage begins when the group establishes cohesiveness and commitment to its tasks, finds new ways to work together to accomplish the tasks, and sets norms for appropriate behaviour [5]. It was observed that all on-campus students started discussions on roles for the project and timeframes straightway without any issue. For external students, their social interaction and communication mainly established online after the virtual pair was assigned. The first step for most pairs trying to define their team norms was to get acquainted with their partner, sharing what kind of skills they were good at and their weaknesses (the design project involved design of steel members based on the steel design

code, finite element analysis using a computer software program and load calculation based on the loading code), and setting up a schedule and workload allocation. Although online meeting (or email) took longer time than face-to-face meeting, most external students seemed either happy with it or they exchanged their phone numbers to start verbal communication.

Trust can be a major issue at this stage for the external students in particular as they had never met each other and didn't know their partner well. A mutual trust will affect the team performance. For example, a student indicated in her questionnaire that she would have to travel a lot during the project time and therefore preferred to work alone. She also indicated that she had very good skills in using the computer software but was weak in steel design. The first author of this paper then tried to match her up with another student who had opposite skills. Both students were informed about the situation and the first author suggested that they talk to each other before making the decision to work as a pair. After some constructive talks, the pair decided to work as a team and promised to stick to the schedule and tried their best to complete the task assigned to each of them, even though they might not be able to communicate for some days. In the end, this pair achieved the highest score in the class for the project.

It was very clear that it took a much longer time for external students to establish their team norms compared with the on-campus student pairs who had usually known each other for three years. However, after the pairs settled into a work process, most external pairs progressed well in completing their project. They all submitted their project before or on the due date, the same as on-campus students. During the first week of the project, a few external students complained that they could not get into contact with their pairs. At this stage, email and online chat were the only way of communication. The first author then passed the mobile phone numbers to these students to attempt alternative contact. It ended up successful for most students except for one pair. The first author then agreed that this student could work alone. This was the only pair who submitted their project individually. It was found out later on that his partner worked in a remote area without internet access before the pair was assigned and the announcement was posted on the online study desk. He only returned to his office two weeks before the project was due. One other student submitted his report as an individual because his partner withdrew from the course one week before the project was due.

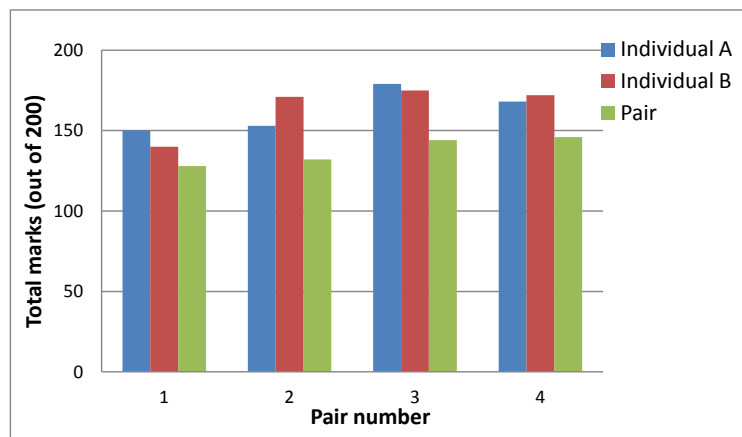
### ***Team performance***

An analysis was conducted to compare the average score each student received from their two previous assignments undertaken as an individual in the same course, with the score they received as a pair in the design project. As shown in Figure 2, each pair's performance in the individual assignment is compared with the group performance. For on campus students where students formed groups by their own choosing, the results are consistent (Figure 2(a)). The group score for each pair was lower than their individual scores. It is also interesting to notice that for each pair of on campus students, the scores of their previous individual assignments were very similar, which indicated that they tended to pair with another student who has a similar academic performance. The average score for on campus students was lower than external students and this may be due to the fact that this particular design project required practical knowledge not just what one can learn from the book. Most external students are working in the relevant engineering firms and therefore have the advantage of both practical experience, and access to experienced design engineers to provide guidance in this area.

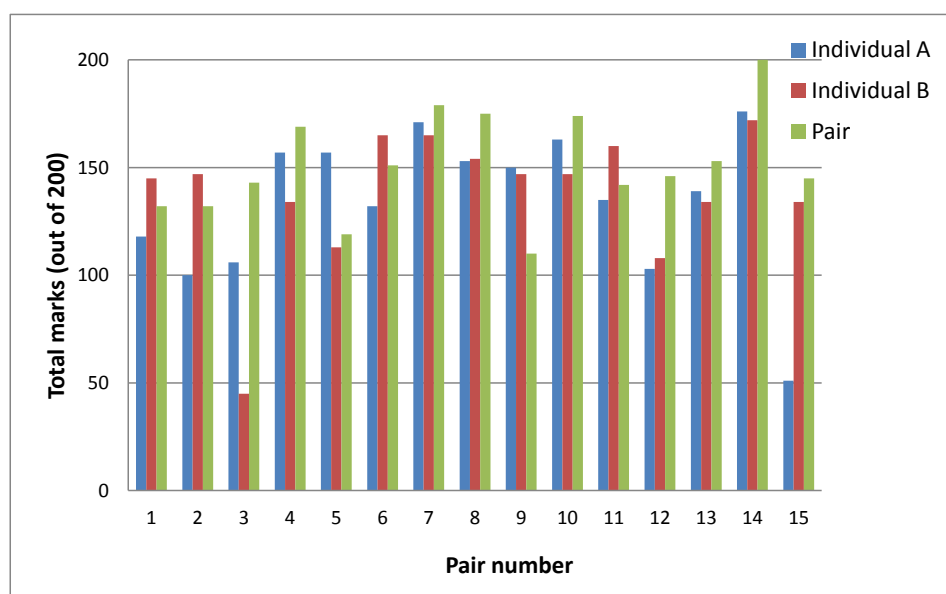
For external students where the pairs were matched up by the lecturer based on the questionnaire to balance strengths and weaknesses, the results are different. In most cases, the scores of each group member's previous individual assignments were quite different,

indicating possible different academic performance. However, as can be seen from Figure 2(b), approximately one third of groups received a score for their team project that was between each individual member's scores from the previous assignments. This indicated that weaker students got more benefit from team work, but this may also be due to the fact that these teams tended to just break the task up, work alone on their assigned sections and then put their pieces together, rather than interacting as a team. At the same time, it was pleasing to see that 60% of pairs received a score that was higher than both of their individual scores from previous assignments. This indicated that both students learned something from each other and achieved a better result than when they had worked alone, which was one of the main aims of the team work process. Only one group (7%) received a score lower than their individual scores from previous assignments.

Another interesting fact is that when the course was offered in 2010 and team work was not compulsory, there were 80 posts related to the design project posted to the study desk to seek help from the lecturer. However, when compulsory team work was introduced in 2011, only 34 posts were posted to the study desk. The number of students who enrolled in the course in these two years was similar. This provides further indication that the team project was achieving the desired learning outcomes (not to mention being beneficial for the lecturer!)



(a) On campus students



(b) External students

Figure 2: Students' performance in group project compared with individual assessments

## CONCLUSIONS

A team design project has been developed and evaluated following on from an unsuccessful implementation in the same course in the previous year. It is well recognised that globalisation and rapidly changing technologies have made online collaboration a common practice in engineering field. It is therefore important to provide our students with such skills. Although specific difficulties are faced by distance education students in participating in team projects, the use of advanced on-line communication technologies can overcome these. Our research found that a good learning outcome could be achieved if the project is well designed and implemented. Regardless of lower or higher levels of prior knowledge and academic achievement, each team member could share his/her strength with the other member to achieve an outcome better than could be achieved alone. However, it was also found that the team score was lower than the individual score for on-campus students, this may be due to the fact that the average score for this project was much lower than other assignments for on-campus students even when they work individually. Due to lack of industry experience, on-campus students (most are school leavers) seem to achieve a lower grade for design project compared to distance learning students where most of them have many years industry experiences.

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### **Biographical Information**

Yan Zhuge is a Senior lecturer in Structural Engineering at the University of Southern Queensland, Australia. Her research interests include sustainable concrete materials, fibre composite structures and seismic retrofitting of masonry structures using fibre reinforced



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Lyn Brodie is an Associate professor of Engineering Education at the University of Southern Queensland. She is the director of Faculty Centre for Engineering Education Research and the coordinator for retention and progressions of the Faculty of Engineering and Surveying. Her research areas are problem based learning, distance education and flexible delivery in Engineering Education, women in engineering and non-traditional career areas.

Julie Mills is a Professor of Engineering Education at the University of South Australia, Adelaide, Australia. Her research areas focus on project-based learning, collaborative building design education, women in engineering and steel structures. She was awarded the Australasian Association of Engineering Education National Teaching Excellence Award in 2009.

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