Students and industry perspective on group work in a first year engineering curriculum at Queensland University of Technology

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BACKGROUND

The ability to work in groups is a key capability for all engineering graduates. An abundance of literature exists on the best way to "administer" group work in an educational setting. Strategies range from particular care in group formations, clarity of roles and awareness of group dynamics, as well as appropriate setting of milestones and progress monitoring to achieve a common goal. These strategies are, however, challenging to apply in a first year, first semester setting. A number of students are there to "taste" engineering, and are not yet fully committed to an engineering program. At the other end of the spectrum, a number of students are very clear about their commitment to the program and expect to do well in all their subjects. In a first year, first semester setting, when students and their aspirations are unknown to the teaching team, group work can be very frustrating and disheartening when the group goals are not uniformly shared.

PURPOSE

At the Queensland University of Technology (QUT), we aim to emulate real professional practice in key units throughout the four years of the Engineering program. The Engineering curriculum at QUT contains a first year first semester unit referred to as "Professional Practice and Sustainability", whereby students work in groups to complete projects informed by Engineers Without Borders. One of the aims of the unit is to provide guidelines for good practice in group formation and group work that can be applied throughout the engineering program.

DESIGN/METHOD

Focus groups and surveys were conducted with students regarding their experience of group work in first year, particularly in the "Professional Practice and Sustainability" unit as well as other units offered in the first semester of the first year. Focus groups were also conducted with industry regarding the essential elements of group work in industry.

RESULTS

Results from surveys and focus groups regarding students' first year experience in group work shows that students do not generally enjoy working in groups, and that group work is "overdone" in first year. It became clearer, however, that students would better enjoy group work if assessed on their individual contributions to the common project. The effect of social loafing would then be less severe and the perception of unfairness would be more subdued. Industry perspective of group work is that awareness of group dynamics, communication skills, negotiation skills, and conflict resolution capabilities should be the focus of assessment in the first year.

CONCLUSIONS

The focus groups with students and industry provided an opportunity for the teaching team of the "Professional Practice and Sustainability" unit to reflect on its current practice with respect to group work. The paper provides current practices in the unit, lessons learned from the focus groups and surveys, and recommendations for improved practice in the unit and across the engineering program.

Introduction

Engineering students are expected to develop teamwork skills and capabilities through their undergraduate degree in order to meet prospective employers' expectations (Rover, 2008). As a result, curriculum in Engineering education generally puts a lot of emphasis on the completion of group projects in an attempt to develop teamwork skills. Simply allocating a common project to a group of students does not, however, necessarily develop teamwork knowledge, skills and capabilities (Crawley, Malmqvist, Ostlund, Brodeur, 2007; Crosthwaite, Cameron, Lant, Litster, 2006). Often, some students in the group take over the work for the whole group. Alternatively, each student in the group does his or her share of the work independently from the rest of the group, and the work is simply assembled at the end (Zou & Ko, 2012). Neither approach facilitates teamwork skills development. Two main issues appear to jeopardise the development of these skills; interpersonal problems and productivity challenges (Natishan, Schmidt, Mead, 2000). Interpersonal problem generally rise due to unequal share of the work, particularly in the presence of social loafing (Van der Duim, Andersson, & Sinnema, 2007; Senadji & Dawes, 2011; Dawes & Senadji, 2011). Productivity problems are linked to a lack of planning strategy, which leads the inability to complete tasks in time (Dutson, Todd, Magleby, & Sorenson, 1997).

In order to truly develop teamwork capabilities, students need to learn and practice a number of skills besides applying technical knowledge to a group project (Lingard, Barkataki, 2011). These skills include time and project management skills, risk management, the ability to communicate efficiently and effectively, the ability to manage change while maintaining ethical and professional conduct.

Strategies to facilitate group work range from particular care in group formations, clarity of roles and awareness of group dynamics, appropriate assessment, as well as appropriate setting of milestones and progress monitoring to achieve a common goal (Ledlow, White-Taylor, & Evans, 2002; Chen, Donahue, & Klimoski, 2004; Adams, Kayes, & Kolb, 2004; Busseri & Palmer, 2000). These strategies are, however, challenging to apply in a first year, first semester setting. A number of students are unsure about their choice of a career in engineering, and are not yet fully committed to an engineering program. At the other end of the spectrum, a number of students are very clear about their commitment to the program and expect to do well in all their subjects. In a first year, first semester setting, when students and their aspirations are unknown to the teaching team, group work can be very frustrating and disheartening when the group goals are not uniformly shared.

At the Queensland University of Technology (QUT), we aim to emulate real professional practice in key units throughout the four years of the Engineering program. The Engineering curriculum at QUT contains a first year first semester unit referred to as "Professional Practice and Sustainability", whereby students work in groups to complete projects informed by Engineers Without Borders (EWB). One of the aims of the unit is to provide guidelines for good practice in group formation and group work that can be applied throughout the engineering program.

Approach to group work in 1st year engineering at QUT

Group work features predominantly in four out of the eight units of the first engineering year at QUT, including the "Professional Practice and Sustainability" unit. Approaches to group work are addressed in the "Professional Practice and Sustainability" unit, but not in the other units where it is assumed that learning can be

transferred. Approaches to group work in the "Professional Practice and Sustainability" unit include:

- A team building exercise whereby students work in team to build the tallest possible tower.

- Writing a team charter to allow the team to set rules and regulations around the group project, as well define a team structure through assigning various roles within the team. A template is provided for the students to use.

- Keeping minutes of team meetings. A template is also provided for the students.

- Conflict resolution techniques with references to extra material for students to read.

- Time management techniques, in particular through the use of a Gantt chart.

The above-mentioned skills are to be applied in the context of an Engineers Without Borders (EWB) contest, whereby teams of first-year engineering students compete to design and build artefacts according to EWB criteria and specifications.

Method

Participants
A group of 8 professional engineers from a range of different disciplines (electrical, mechanical, medical, and civil engineers) were invited to participate in a focus group on team capabilities. A learning and teaching designer asked facilitated discussions around the importance of group work in first year, the aspects that are more relevant to industry and the best way to emulate a professional setting.
Students in 2nd, 3rd and 4th year engineering were also invited to participate in a different focus group and were asked questions about their group work experience in general, and the best and worst aspects in particular. Finally, first year students in the "Professional Practice" unit were also invited to reflect in writing and in general about their experience in the unit. They were not particularly invited to discuss their group work experience. This paper reports the reflections that best described best and worst aspects of group work in first year engineering.

Procedure
Students participating in the focus group were asked questions about their experience in the degree in general, and were asked to comment on particular aspects of their course experience, in particular group work.
The results from the focus group with students helped frame questions and discussions within industry members in a later focus group.
Students in the first year in the "Professional Practice" unit were asked to provide a brief (one to two pages) reflection on the unit in general.

Results and discussion

Results consist of feedback received from the focus group sessions with Industry and later year Engineering students with respect to Group work in the Engineering degree at QUT, as well as written feedback from 1st year Engineering students enrolled in the Professional Practice unit.

Value of Group work

The reflection reports written by first year students in the Professional Practice unit show that students generally understand the value of group work.

- *"Working in a team is a major part of being an engineer and this subject undoubtedly develops key teamwork skills."*

- *"As an engineer, we will constantly be required to work in teams. This is a very important skill that I feel I have developed through the unit."*

However, despite acknowledging the importance and apparent value of group work, students in the focus group did not appear to fully enjoy their group work experience.

- *"Group work is overdone in first year"*
- *"We understand the value of it, but we do too much of it".*

Group assessment appears to be one of the elements students in first year enjoy the least about group work. Students' perception is that, in later years, they are able to choose their team; they know the students they work well with and who to avoid. In first year, however, when all students are new, it is difficult to identify students' aspirations and level of commitment to the engineering studies they are undertaking. Some students are there to "try" engineering, while others may already be working in an engineering setting, and are studying to obtain a qualification to support the work they are already doing. When these two extreme types of students end up in the same group, as has happened, the experience of group work can be particularly negative, especially if all students achieve the same grade regardless of their individual effort and contribution. The following two comments reflect the two extremes that can coexist in a group and the challenges associated.

- *"Perhaps the largest obstacle I found on the challenge was the different academic abilities and previous experience of team projects that members had encountered, if at all. I had many years' experience working on projects in the workplace and studying, so was familiar setting deadlines for tasks in a team. This was also the experience of some other members. For some of the team, they came from an educational background that did not provide teamwork opportunities as often if ever. Having to work in a team structure was therefore a challenge I think both for those not experienced and also those of us quite experienced."*

- *"It was the first time I have ever been involved in a group assignment. It was a challenge for everyone to stay on the same page."*

One of the possible solutions to overcome these extremes is to lighten the load and expectations of group work in first year, until students get to know each other and form more homogeneous groups.
However, when industry members were asked if group project work should be left to later years after students get to know each other, the response was a unanimous "No".
- *"Students need to be involved in teamwork right from the start."*

Industry members further reflected that the ability for students to communicate and resolve conflict within a team is one of the most crucial skills for students to develop.
- *"Focus in first year should be on their individual teamwork capabilities, such as conflict resolution skills, rather than on the outcome of the project".*

Communication skills

The "Professional Practice" subject also puts a lot of emphasis on communication skills for smoother team operations. It appears, as shown in the comments below, that students generally recognise the value of various communication skills for successfully running a group project.

- *"Knowing how to work with other people is one major part of those steps. In this part, proficient communication skills, multicultural skills, and healthy ethics skills are significant in engineers' daily life. Through the EWB project, I have practiced and felt those skills factually."*

- *"Team meetings improved my communication with my team mates and possibly future team mates."*

- *"Through the completion of this project, the team has overcome many obstacles which have tested our communication skills in order to succeed as a team. The biggest obstacle was coordinating 6 people to each work on individual parts of a much larger project, and ensuring the final project flowed well and did not suffer as a result of this. "*

The subject encouraged "face-o-face" communication and even provides a template for team meetings, but also acknowledged the value of remote communication particularly when students within a group have different time commitments.

- *"Alongside teamwork, communication played a massive role in how progress was made with the EWB challenge. Various means of communication that I have previously not used was implemented by and for team communication such as online dropboxes and file exchanges. While this came with a learning curve and adjustment, forms of new online communication proved beneficial for the group."*

Time and Project management
As mentioned earlier, the lack of planning strategy, and the inability to complete tasks in time (Dutson, Todd, Magleby, & Sorenson, 1997) is one of the major stress factors in teamwork. One the most successful achievement of the "Professional Practice" subject is the ability to teach time and project management through Gantt Charts. Students generally respond well to Gantt Charts as shown by the comments below.

- *"Time management techniques and indicators such as Gantt charts have significantly aided our group."*

- *"Project management was another skill learnt first hand during ENB100 as the group project seemed daunting at first. Regular team meetings and the ability to design and implement a Gantt chart resulted in a cohesive and effective team."*

Learning, however, is not necessarily always easy.

- *"The most challenging part of this unit would be the planning process for our group project. This is because much of the planning included foresight of information we did not have. I found that planning required many continuous amendments, as the more our knowledge of our project topic increased the more we had to continuously tweak our design itself. We had to continuously amend our Gantt chart to reflect any changes in the design process and project in general. This proved to be an extremely annoying task, however it does provide a valuable lesson in time management for future projects."*

Conflict resolution
As indicated in (Van der Duim, Andersson, & Sinnema, 2007; Senadji & Dawes, 2011; Dawes & Senadji, 2011), the main source of conflict within a group is due to

uneven workload and social loafing. This is further reflected in the students' comments below.

- *"There were some difficulties during the EWB task that I had trouble overcoming. Although I improved my teamwork skills, I found it difficult to ensure other members of the team completed set tasks each week. It was a daunting task to ensure every team member was pulling his or her own weight. Some sections of the report were not completed by members thus I had to write these sections instead."*

Some students found effective ways of resolving issues through communicating,
- *"Ways to handle team problems were learnt along the way. I have learnt that the best way to solve a team problem is to gather together and discuss ways to solve it together."*

However, most students faced with social loafing challenges were unable to resolve them, despite a team charter that clearly stated consequences for violating team agreements.

- *"Team problems such as the uneven distribution of workload, lack of interest in the subject, and the consistency of determination has been the biggest problem in the group. I have learnt that a team does not always work efficiently and positively."*

But these challenges can sometimes result in positive reflections from students, as shown in the comment below.

- *"I believe I became a better leader as a result of other members not pulling their weight. "*

When industry members were asked to comment on the uneven workload encountered in group project, they replied:
- *"It's the same in Industry anyway. People learn who they can work with and who they shouldn't work with."*

They, however, commented that if the team project was suffering as a result of loafing, the Project Manager would be called in. Consequences would be applied, and the issue would generally be resolved. Other industry members also commented that the issue would also come up in Performance Review meetings, and consequences would also appear as a result.
It appears, therefore, that to emulate a professional setting, a "Manager", most probably in the form of an academic, needs to be called on in extreme cases to resolve issues of uneven workload and social loafing, and that an individual assessment of each team member's performance also needs to be put in place.

Conclusions

At the Queensland University of Technology, a first year, first semester, "Professional Practice" unit was designed to emulate real professional practice in a variety of areas. The focus of this paper was "teamwork" and the learning of associated skills and capabilities. Through students and industry focus groups, as well as written reflections by students undertaking the subject, we reflected on things well done, as well as things that could possibly improve in the unit. We found that students particularly appreciated learning and applying project management and communication skills, even though the learning was often through a steep curve.
Feedback from industry was industry was that more emphasis was required on conflict resolution skills, which particularly arise in the presence on uneven workload or social loafing. Industry members also emphasised that managers tended to

resolve issues that significantly threatened to delay projects, and the unit would probably benefit from emulating the presence of project managers. Finally, individual assessment of particular teamwork skills could be added to the already existing group assessment. Below is a realistic comment from a first year student enrolled the "Professional Practice" unit, and a good concluding statement for this paper.

- *"Teamwork difficulties will continue throughout my time at university and throughout my career. It was an eye opening challenge, however it was better to discover these problems exit at the beginning of my degree rather than in the workforce."*

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