Self and Peer Assessment to Promote Professional Skill Development: Moving from Ad-Hoc to Planned Integration

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Abstract: *Professional skills including self reflection, critical evaluation and an ability to work in teams are important for all practising engineers. While most undergraduate engineering programs contain some instruction to help students develop professional skills, the ongoing development of these skills is often treated on an ad hoc basis. This paper reports the coordinated use of an online tool to collect student's self and peer assessments in three core engineering subjects, to provide students with an explicit opportunity to learn, develop and practise these skills over three years of their degree. We found to promote enthusiasm and engagement by both staff and students it is necessary to provide documentation, instruction and practice to understand the rationale for using self and peer assessment and to become comfortable with the feedback processes designed to encourage students to become reflective learners. Without the correct training, tutors who do not possess the required skills may choose to opt out of the process.*

Introduction

The skills of self reflection, critical evaluation and an ability to work in teams are important for all practising engineers. Often these skills are underdeveloped by students during their degree programmes. This may be in part due to the fact that undergraduate courses often don't have a coordinated approach to teaching, practising and monitoring ongoing development of these skills. While most undergraduate engineering programs contain an Engineering Communication subject where instruction is given to help students develop professional skills, the ongoing development of these skills is often treated on an ad hoc basis for the rest of their degree. This paper reports our efforts to use self and peer assessment in three core engineering subjects at the University of Technology, Sydney (UTS), to provide students with a coordinated opportunity to learn, develop and practise these skills over three years of their degree.

Background

A number of researchers have reported that the level of teamwork skills developed by engineering students during their undergraduate courses is not sufficient to satisfy employer requirements (Martin 2005; Meier, Williams & Humphreys 2000). In addition to being technically competent professional engineers require skills of collaboration, communication and the ability to work in teams (Lang et al, 1999; Sageev & Romanowski 2001).

While team-based projects provide opportunities for team interaction they do not necessarily facilitate the development of teamwork skills (Natishan et al, 2000). Students need to understand team

dynamics, how to resolve conflict and the importance of doing so. While this can be facilitated by instruction, it is insufficient on its own (Messer, 2001; Stonyer & Dodd 2001).

University courses need to develop learning-oriented assessments that not only develop these skills but promote future development and learning after graduation (Boud & Falchikov, 2006). The first step is to develop a method of assessment that not only tests such outcomes but also promotes their development. Secondly, since the development of teamwork skills is an ongoing process, courses should be designed such that these skills are practiced and reinforced regularly throughout a degree program. Self and peer assessment can be used to address both of these issues.

The use of self and peer assessment has been widely reported in the literature (Goldfinch 1994, Goldfinch & Raeside 1990, Falchikov & Goldfinch 2000). In this paper we report the use of an online tool called SPARK (Self and Peer Assessment Resource Kit) (Freeman & McKenzie 2002, SPARK 2007), to facilitate confidential self and peer assessment to focus students' efforts on learning and practicing the skills required for teamwork. Unlike other self and peer assessment packages, SPARK automatically produces two factors. The first factor, (Self and Peer Assessment or SPA factor) is a weighting factor determined by self and peer rating of a student's contribution that can be used to change a team mark for a project (stage) into an individual mark.

$$\text{Individual mark} = \text{team mark} * \text{Individual's SPA}$$

The second factor is the Self Assessment to Peer Assessment factor (SAPA). It is the ratio of a student's own rating of themselves compared to the average rating of their contribution by their peers. The use of the SAPA factor has strong feedback value for development of critical reflection and evaluation skills.

The SAPA factor provides students with feedback about how the rest of the team perceived their contribution. For example, a SAPA factor greater than 1 means that a student has rated their own team performance higher than they were rated by their team peers. Conversely, a SAPA factor less than 1 means that a student has rated their own performance lower than they were rated by their peers. While the SPA factor is typically used only for summative purposes, both factors can, and we believe should, be used for formative purposes as well.

Building on previous research (Willey 2006a, Willey 2006b) we have incorporated self and peer assessment into three consecutive core subjects in the engineering program at UTS. This provides ongoing opportunities for students not only to practise but assess their continuing professional skill development. This paper reports our initial implementation and explains what we are attempting to achieve in each subject. We then discuss the results of the first trials, in particular focusing on what needs to be improved.

Method

The engineering degree at UTS consists of eight academic semesters combined with two semesters of professional practice. The core program is a stream of subjects that runs through the entire degree and taken by all engineering students. The three core subjects used in our trial implementation were Engineering Communication, Design Fundamentals and Engineering Project Management. Self and peer assessment is used in each subject to both promote and assess discipline specific tasks, team work skills and team contribution.

Our aim is to use self and peer assessment processes to move students from being novices to become more expert in their professional skills development as they progress through their degree. Students in Engineering Communication (Jacobs and Griffiths 2004) are introduced to the on-line tool SPARK. The subject provides an opportunity to become familiar with its use and to support students in using self and peer assessment to promote effective group work. These skills are further developed in Design Fundamentals where self and peer assessment is used three times to not only convert group project marks to individual project marks, but to facilitate tutor facilitated feedback sessions. In these sessions students give and receive feedback on technical and teamwork issues to promote skill development and improve subsequent performance. In Engineering Project Management students are asked to independently make their self and peer assessments and to provide feedback to their team peers not

only on their performance but on how to improve their team management processes. A comparison of each subject including how self and peer assessment is used is given in Table 1:

Table 1 Outline of the three subjects used in the trial including how and why self and peer assessment is used.

	Engineering Communication	Design Fundamentals	Engineering Project Management
Subject aim	• Introduces students to many communication issues they will face and skills they will need as engineers, including: • writing (engineering reports and conference papers) • team management and working in groups • implications of plagiarism and inadequate referencing • reflective thinking skills	• Develop students' understanding of the engineering design process • Develop students' skills to build a small engineering project from initial concept to prototype production. • Promote the development of professional skills including teamwork, critical evaluation, feedback, communication skills and academic honesty.	• Introduce students to the tools and techniques associated with Project Management • Continue the development of team work skills
Cohort size (Aut 07)	550	260	168
Tutorial size	30	32	approximately 55
Small group size	4 - 6	4	5 - 6
Groupwork task	• written report and oral presentation	• team delivery and management of multistage engineering project, written reports and oral presentation	• team management and engineering project management of a group project. Written report and oral presentation
Level of understanding of self and peer assessment	• novice	• developing	• competent
Subject runs in	• semester 1 or 2	• semester 3 or 4	• semester 6 or 7
Number of times self and peer assessment is used during semester	2	3	2
Why self and peer assessment is used.	• introduce students to the concept and value of self and peer assessment • develop student's familiarity with the SPARK tool to support its use in later subjects • facilitate management of and feedback about groupwork issues	• provide constructive feedback to students on their teamwork skills and how they are contributing to their teams • allow students the opportunity to learn from this feedback to improve subsequent performance. • determine individual assignment marks by appropriate adjustment of group marks • Discourage free-riding	• give and receive feedback on their performance through the project and allocate marks among group members
Marks awarded from SPARK exercises	• moderation of mark for group report	• marks awarded for completing self and peer assessment exercise and participating in feedback sessions. • moderation of marks for each stage of the group work project	• moderation of project mark

Support provided	• tutors • worksheets developed for Spring 07	• tutor facilitated feedback sessions • Scaffolded Feedback process • Appeal mechanism	• independent

Results

Engineering Communication and Design Fundamentals tracked students changing attitudes through the use of both Pre and Post subject surveys. Only a Post subject survey was used in Engineering Project Management. As this paper reports all three subjects, for consistency we will only present results of the Post subject surveys. Most of the survey questions were written in 5-point Likert format. The results of these surveys are summarised in Table 2. The first figure reports the combined percentage of the two positive response options with the percentage of neutral responses shown in brackets. A blank box means that this question was not asked in the survey for this subject.

Table 2 Post self and peer assessment survey results for the subjects used in the reported trial.

	Engineering Communication	Design Fundamentals	Engineering Project Management
	Post-SPARK	Post-SPARK	Post-SPARK
Cohort	550	220 (excluding students who were exempt from part of the project)	168
Respondents	95	95	147
Survey	Online	Online	Paper based in Class
Respondents who had previous experience using self and peer assessment	33%	37%	34%
Compared to my previous experience with group work, the use of self and peer assessment facilitated by SPARK has made group work fairer	56% (34%)	58% (26%)	58% (22%)
The use of self and peer assessment encouraged **me** to put more consistent effort into my assigned work for the project.	56% (29%)	54% (32%)	44% (31%)
The use of self and peer assessment has encouraged **otherwise lazy group members**, to put more consistent effort into their assigned work for the project.	45% (25%)	51% (20%)	51% (27%)
Multiple uses of self and peer assessment and the associated feedback sessions improved **my** ability to both assess my work and the work of others.	Opportunities did not occur	67% (18%)	51% (32%)
Overall the project has enabled me to develop skills necessary for working as part of a team.	74% (14%)	78% (14%)	62% (19%)
Overall the formative feedback process (including the feedback sessions and the sharing of SPARK factors amongst group members) promoted honest assessment of group work.	56% (29%)	69% (19%)	
My group progressed from group cooperation early in the semester to more active collaboration and teamwork.	77% (17%)	71% (19%)	
My tutor was enthusiastic about the use of self and peer assessment facilitated by SPARK.	71% (17%) Note most respondents had enthusiastic tutors	55% (32%)	73% (22%)
Using self and peer assessment facilitated by SPARK improved my group work experience	40% (37%)	56% (28%)	40% (41%)

The formative feedback I received from my tutor helped me to improve my performance in the subject.	64% (17%)	63% (25%)	
The formative feedback I received from my group helped me to improve my performance in the subject.	68% (19%)	48% (38%)	53% (32%)
The formative feedback I received from my tutor will help me to improve my performance in future subject.	68% (18%)	70% (20%)	
The formative feedback I received from my group will help me to improve my performance in future subjects.	62% (31%)	58% (38%)	51% (36%)

Discussion

Engineering Communication

While there were some encouraging signs, the results this semester in Engineering Communication were disappointing. In the first trial there were issues with encouraging completion of the assessment with only 8% of the cohort participating, with no groups having sufficient members complete the first exercise to enable meaningful feedback sessions to be conducted.

Some staff who had no prior experience with the SPARK tool had concerns about the validity of this method of self and peer assessment and were reluctant to encourage its use in their tutorials**.** Others found it difficult to force completion by the majority of students due to lack of familiarity and not appreciating the relevance of the exercises.

While the second self and peer assessment exercise had sufficient completions (with 90 % of the cohort participating) to allow the SPA factors to be used to moderate group marks into individual marks, the results were obtained so late in semester, that feedback sessions were not adequately addressed due to time constraints. This semester additional tutorial time has been allocated for facilitated feedback sessions to be held.

While the fact that the subject coordinator, most tutors and all students in this subject were **first-time users** of the SPARK tool probably contributed to some of the above mentioned issues, perhaps the biggest issue to address in future use of the SPARK self and peer assessment tool (or any other) is tutor engagement, familiarity and comfort so that they can, in turn, encourage the use of SPARK as both an assessment and learning tool for students by promoting reflection on actions.

Design Fundamentals

The Design Fundamentals subject coordinator was an experienced user of self and peer assessment processes and in particular had used SPARK as a collection tool in various contexts for the last five years. This was the third semester in which self and peer assessment had been used in Design Fundamentals. The subject has been specifically designed to simultaneously develop disciplinary skills in engineering design while promoting the development of students' professional skills including teamwork. Self and peer assessment has proved an effective tool in achieving this.

The subject typically involves the use of eight tutors. Some staff, while happy to use self and peer assessment as a means of detecting and punishing group free riders, felt uneasy helping students develop their professional skills. In most cases this was due to inexperience with self and peer assessment processes and a lack of practice at facilitating small group discussions on non-analytic skills. Prior experience has shown that most tutors need to participate in the subject for at least one semester before feeling comfortable with facilitating the feedback sessions and in particular helping students to interpret their feedback factors.

Students are given 2.5 marks for completing each self and peer assessment exercise and participating in the facilitated feedback sessions. This ensures a high participation rate typically >95%. To receive the marks students must demonstrate that they have engaged with the learning outcomes. This is assessed in a number of ways including tutors asking each group questions in relation to their teamwork and team contribution during the feedback sessions. In addition, students who were found attempting to sabotage the process by submitting dishonest assessments received zero marks.

Suspected sabotage is identified by academics through the comparison of students' feedback factors and by students through a formal review process.

We found that providing all team members with the SAPA (formative feedback) factor encouraged more realistic and honest self assessments, as participants who inflate their self ratings are typically exposed by a high SAPA factor. Providing feedback multiple times during a semester affords students an opportunity to reflect and modify their group behaviour, effort or approach to the remaining parts of the project. Hence they have an opportunity to practise and test what they have learnt. Many groups who perform poorly in the first part of their project, respond positively to this feedback, significantly improving their performance in the remaining stages of the project.

Engineering Project Management

At first glance the results from the survey appear disappointing in that only a small majority (58%) felt that the use of self and peer assessment had made group work fairer and a minority (40%) believing that it had improved their group experience. In future semesters, we will endeavour to determine how many of the students who reported no improvement in their group work experience were members of effectively functioning teams, or alternatively because of earlier exposure to the concept of self and peer assessment, had already developed the necessary teamwork skills.

More encouraging was the fact that just over half of the respondents reported that the student facilitated feedback sessions (held when the SPARK factors were distributed) not only helped them to improve their performance in the subject (53%) but would help them to improve their performance in future subject (51%).

While 73% of respondents reported that the lecturer was enthusiastic about the use of self and peer assessment, as a first time user of the SPARK tool the lecturer (who also acted as a tutor) found it confronting to run the feedback sessions. In following semesters more time will be allowed for this exercise and a more structured approach to the feedback session will be adopted. This semester the concept of giving and receiving feedback from group members has now been introduced into the weekly jargon for this subject. It is hoped that this will increase student's engagement and appreciation that feedback skills are both important and necessary for successful group work.

General

Before designing any learning opportunity careful consideration must be given to what you are trying to achieve and what you want students to learn. Even subtle differences between valid approaches to developing teamwork can promote different learning outcomes. For example there is a difference between getting teams to work effectively and developing students' teamwork skills. Purposely selecting teams that will work well together may improve the quality of work produced by the group and improve the team work experience but it does not necessarily help students develop the full range of required teamwork skills. Students need to also develop skills to work in teams that may suffer from some dysfunction or conflict, may contain two or more dominate personalities etc. They need to develop processes and a language to manage and if possible resolve these issues. As reported we have introduced feedback sessions after each self and peer assessment exercise to help students develop these skills. We are currently in the process of refining these feedback processes to more specifically target the needs and skills of students at the different stages of their degree.

Ellis et al reports in relation to monitoring online bulletin boards that "it cannot be assumed that tutors will automatically adopt the most useful approach to mediating discussions as they may not fundamentally understand their purpose" (Ellis 2004). Similarly in our trials we found that for students to receive the full benefit from using self and peer assessment processes tutors need instruction, training and practice to understand and engage with the desired learning outcomes. We found this to be particularly true in regard to the facilitation of feedback sessions. In some cases it appeared that some tutors were not proficient in the very skills we were expecting students to develop. Without the correct training, tutors who do not possess these skills may choose to opt out of the process.

In future semesters we intend to keep a record of students SPA and SAPA factors for each category of criteria eg teamwork skills and project management. One way to do this is have students include their

factors in their soon-to-be-introduced e-portfolio. This will allow students to both track and monitor their development over the course of their degree.

Recommendations

Over all the initial trials in Engineering Communications were disappointing with generally poor participation and engagement by both staff and students, who were mostly first-time users of self and peer assessment processes. In addition, the fact that the large cohort required the use of 12 different tutors to run 20 tutorial classes meant there was insufficient time to provide well supported instruction into the self and peer assessment processes used in the subject. However, approximately 50% of respondents found using self and peer assessment encouraged complete and on-time work (56%) and lazy group members (45%) while making team work fairer (56%).

In comparison the Design Fundamentals trial with integrated feedback sessions were extremely successful with 69% of respondents agreeing that they promoted honest assessment, improved their teamwork (56%), critical evaluation (67%) and feedback (68%) skills. These results need to be interpreted with the knowledge that this was the third time that self and peer assessment processes had been used in this subject, the subject coordinator had five years experience with using the SPARK tool and only two of the eight tutors had no previous experience with facilitating the use of self and peer assessment.

The Engineering Project Management trials proved effective despite the fact that 66% of respondents had no previous experience in using self and peer assessment with just over half of the respondents reporting that it discouraged group work free riders (51%) and made team work fairer (58%). Again the subject's staff were first-time users of self and peer assessment processes reporting that it was particularly confronting to run the feedback sessions. However, most Engineering Project Management students are two thirds of the way through their degree and hence are considered to be better equipped to deal with self and peer assessment processes than those in the earlier subjects.

Perhaps the most encouraging result was the fact that approximately 50% of respondents in all subjects reported that the formative feedback they received from both their group members' and tutor's helped them not only to improve their performance in the subject but also expect it to help them improve their performance in future subjects. We suggest that this amount of constructive feedback may not have occurred without the use of self and peer assessment with integrated feedback processes.

It is interesting to note that despite the success of the Design Fundamentals trial (mostly experienced staff users) only 54% of respondents said that their tutors were enthusiastic about self per assessment processes. This compares to 73% (Engineering Project Management) and 71% (Engineering Communications) where the vast majority of the staff were first time users. This suggests that while enthusiasm is both necessary and important it is insufficient on its own. Tutors need to receive both instruction and training and gain some experience for students to receive the most benefit from self and peer assessment exercises. To make the exercises more successful in future semesters we believe that for first-time users it is paramount that:

- Sufficient documentation of the process and practise with the software be provided to ensure the staff are both familiar with the rationale for using self and peer assessment as a teaching tool and comfortable with the software. Staff must also be comfortable with the feedback process required to encourage students to become reflective learners.
- Sufficient time is allocated to permit the feedback sessions held after the use of self and peer assessment exercises to be a meaningful activity for students.
- Support is given to first time users, encouraging them to 'have a go' and advising them that most people find it difficult the first time round. If possible suggest they attend a 'feedback session' run by a more experienced facilitator to gain insight into the best way to approach these sessions.

Furthermore to ensure students receive the required support to engage with the self and peer assessment processes the subject pre-requisites have been changed to ensure that students complete the subjects in the recommended order.

Conclusion

In this paper we report the coordinated use of an online tool to collect student's self and peer assessments in three core engineering subjects at UTS to provide students with an opportunity to learn, practise and track their on-going skill development over three years of their degree. We found that to promote enthusiasm and engagement by both staff and students it is necessary to provide documentation, instruction and practise to understand not only the rationale for using self and peer assessment but to also be comfortable with using the software tool. Furthermore tutors need instruction and time to become comfortable with the feedback processes required to encourage students to become reflective learners. Without the correct training, tutors who do not possess the required skills may choose to opt out of the process.

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