A process for proactively ensuring student team success: perceptions of students and lecturers

Lydia Kavanagh
The University of Queensland, St Lucia, Australia
l.kavanagh@uq.edu.au

Jasmine Steer
The University of Queensland, St Lucia, Australia
j.steer@uq.edu.au

***Abstract**: In 2007, a comprehensive process for proactively ensuring student team success was introduced to the 1st year team-based flagstone course: 'Introduction to Professional Engineering'. This course was taken by approximately 850 students in 180 teams necessitating a teaching team of 40. The process involved purposeful team selection, team mentoring, individual reflection, and peer assessment. The application was deemed a success as only one student team failed through dysfunction, there was a noticeable reduction in complaints, and the overall perceptions of both staff and students were favourable.*

Introduction

The use of student teams in undergraduate engineering education has proved to be successful: students are more confident, more able to apply engineering competencies, solve problems working from first principles, and work in teams and on realistic industrial projects (Crosthwaite et al. 2006). However, this result does not arise simply from ensuring that projects are purposefully selected to fulfil a detailed set of learning objectives. Instruction and support tailored to enable the achievement of all the desired learning outcomes must also be provided.

Acquiring proficiency in generic skills, such as team working and time management, requires the students to do more than attend technical key-note lectures and hands-on workshops (Jones 1996, Smith 1996); generic skill acquisition requires a level of experiential learning (Moy 1999). However, a student who spends all semester managing a dysfunctional team without help may not achieve technical learning objectives and thus may fail the course (Courtney and Rouse 2006). In addition, team dysfunction is usually not discovered until it is too late for intervention (Jones 1996).

Two major causes of dysfunctional teams are social loafing[1] and unresolved conflict; students find it difficult to report the former and try to sort the latter out internally even when the situation is irreconcilable without outside intervention. Two further issues, those of leaderless teams and initial team formation, are recognised as contributing to team dysfunction. The former issue is one that has been experienced by the authors but that is rarely recognised by literature. Indeed many (e.g Zeff and Higby 2002) believe that the leadership role is shared by team members.

The latter issue, that of initial team formation, draws a wide range of response from researchers: some supporting completely random teams (Foyle 1995) and other organising groups based on ensuring a good mix of skills and experience or personalities (Schlimmer et. al. 1994, Michaelsen 1995). In some cases, an evaluation has been undertaken to establish the success of purposefully forming teams but results have been inconclusive (Huxham and Land 2000, Shelnutt et. al. 1996).

[1] Social loafers are also called free-riders. "Free riding is a form of social loafing seen in a group when one or more members slack off and 'ride' on the extra efforts of their coworkers." (Walker et al 1998)

In order to proactively ensure that student teams do not become dysfunctional, a process known as the PETS (Proactively Ensuring Team Success) process was developed in 2004 and has been implemented in an increasing number of courses across the campus at The University of Queensland (UQ). In 2007, it was applied in its entirety to the 1st year flagstone engineering subject ENGG1000 (Introduction to Professional Engineering). This paper outlines the process and analyses qualitative feedback on the process from both students and staff involved in the subject.

The process

Table 1 outlines the various stages in the PETS process as applied to ENGG1000. A sample of the available references for each stage of the process has been included.

Table 1 PETS Process Overview

STAGE/ STEP	ACTION	REFS
1. Setting it up		
1.1 Define your learning outcomes	Learning activities must not only advance students' knowledge of the field of study but should also try to enhance their graduate attributes.	Kavanagh and Crosthwaite 2007
1.2 Design the team projects	Ideally the assignment should incorporate: different deliverable formats, sub-tasks that can be completed by an individual or a pair of students and perhaps attract an individual mark, a final section which requires sub-tasks to be integrated, analysed and discussed by the team, various milestones to aid time management, and learning objectives which can be tested by hurdle assessment such as pass/ fail quizzes.	Pimmel 2003
1.3 Recruit and brief teaching team	There are a variety of roles to be performed in any course. These might include: the course co-ordinator, lecturers, tutors, and team mentors. It is recommended that the teaching methodology and responsibilities be decided before semester begins. Teaching staff new to working with student teams and the PETS process should be given training. In ENGG100 this takes the form of 2x 3 hour workshops for the 40 or so project staff involved.	Kavanagh and Crosthwaite 2007
1.4 Allocate students to teams	Teams are allocated, ensuring that as far as possible each team: has one or more students who will provide leadership, does not contain a disproportionate number of students who are prone to social loafing, does not have a disproportionate number of students for whom English is their second language (ESL), and has a balanced number of males and females with respect to the amount of each taking the course. The Belbin team roles inventory or looped knowledge is used to determine those students who may be able to provide team leadership.	Michaelsen 1994, Belbin 1989
1.5 Upload web resources	The use of a course website can aid student team work in a number of ways: providing teams with their own discussion board, allowing teams to upload work, providing an easy way of communication, and encouraging inter-group discussion.	
2. Start of Semester		
2.1 Communicate processes to students	The PETS process strategies need to be disseminated to the students in order for them to become effective. This communication needs to be made in the initial lecture to emphasise the importance of team work and the penalties for social loafing and unresolved team dysfunction. The first lecture needs to cover the following points: the importance of team work in terms of achieving learning objectives and final deliverables, the intentional selection of teams to maximise student potential and performance, the strategy for addressing social loafing, the peer assessment factor (PAF – see 4.2 below), the team assessment mark, the reason for, and value of, initial workshops and mentor meetings.	

2.2 Team formation exercises	The initial activities should be planned to allow both team formation and continued team collaboration. This is best done if the activities achieve both project and team requirements and thus appeal to the student. Having students draw up both team rules and a Gantt chart for the semester's work is commonly used.	Blair 1993, Grulke 2001
3. During semester		
3.1 Individual student reflection	Prior to each mentor meeting, it is important for each student to reflect on the team progress and the team process. This reflection is anonymous in that other students do not have access to this document: only the team mentor.	Gardner and Korth 1997
3.2 Mentor meeting	Mentor meetings are held on a formal basis with all team members present and can be anywhere from 30 to 60 minutes in duration depending on the detail involved in the project and the check list tasks to be evaluated. They should provide support on three levels: technical, time, and team.	Courtney and Rouse 2006, Kavanagh and Crosthwaite 2007
3.3 Address social loafing	One of the outcomes of Mentor Meetings and anonymous student reflection is that students who are social loafing will be identified through the PAF (see 4.2 below), other team member comments, and your observations. It is recommended that the teaching team discuss any issues to decide the best course of action: team or individual mentoring, or perhaps team re-assignation.	Blair 1993, Jones 1996, Kavanagh and Crosthwaite 2007
3.4 Formative assessment	Mentor meetings provide the ideal situation for formative assessment allowing the student and the student team to receive feedback on technical, time-management, and team processes.	Gardner and Korth 1997
3.5 Hurdle assessment	There is often a basic core of knowledge that students must have in order to complete the team project. Hurdle assessment is one way of ensuring that all students have that basic knowledge and thus take part in the team project.	Kavanagh and Crosthwaite 2007
4. Getting over the line		
4.1 Delivery of project	Wherein the student team submits deliverables.	
4.2 Peer assessment of individual performance	Each deliverable is accompanied by a Peer Evaluation Form. This form requires the students to distribute 100 points between each of the team members and has space for a comment; it is filled out anonymously so that other team members do not see it. The points given to each student are averaged and then used to calculate the Peer Assessment Factor (PAF) which is applied directly to their project mark.	Gardner and Korth 1997, Burtner 1997, Shelnutt et. al. 1996, Kavanagh and Crosthwaite 2007
4.3 Team meeting for feedback	Reflection and feedback to teams is essential to capitalise on the semester's learning experiences and to carry forward team skills with cognitive knowledge of what has gone before. A final non-compulsory mentor meeting can therefore be offered.	
4.4 Marking and processing of results	Wherein individual and team-based assessment is collated and a final grade awarded to each student.	Johnson and Johnson 2003
5. Reflection and review		
5.1 Student evaluation	Student feedback is of paramount importance to the team strategies developed for your courses. It can be collected through a number of the strategies incorporated in the process of ensuring team success: individual reviews for mentor meetings, mentor meetings, peer evaluation forms, and final team feedback meetings. Specific questionnaires can also be designed.	
5.2 Teaching team	In addition to feedback from students, it is found that the experiences	

reflection	of all those involved with the delivery of the course is highly valuable. Over the years, we have gained many valuable insights from our teaching colleagues as well as infusing them with an interest in improving pedagogy.	

The context

The standard enrolment for a full time student is four courses per semester with each course allocated a maximum of five hours of formal class contact time per week over 13 teaching weeks. Team project work accounts for 25% of the curriculum each semester and is the framework around which the entire curriculum is built. A project course, such as ENGG1000, typically comprises two (2x) one hour per week keynote lectures, and between one to two hours per week for hands-on workshops. Any remaining formal class contact time is allocated for team project work. Towards the end of semester, less time is allocated to lectures and workshops and therefore more time is dedicated to team project work. ENGG1000 is compulsory for all engineering students.

The aims of ENGG1000, Introduction to Professional Engineering, are best described using the introduction from the course profile (2007):

> *You are embarking on your university studies to become a professional engineer. It is highly likely you will play an important role in addressing the key challenges for the 21st century such as provision of water resources, infrastructure and communication, food supplies and health services and development of new sustainable energy economy. In your first year, much of your time will be spent on the mathematical and scientific basics that underpin all engineering disciplines. However, being a professional engineer is much more than the application of these sciences. Engineers Australia (our professional engineering body) defines the attributes needed by a graduate professional engineer under five headings:*
>
> *1. In-depth Knowledge of the Field of Study*
>
> *2. Effective Communication*
>
> *3. Independence and Creativity*
>
> *4. Critical Judgement*
>
> *5. Ethical and Social Understanding*
>
> *This course begins to address the attributes under headings 2 to 5, and encourages you from day 1 of your studies to think like a professional engineer. ENGG1000 is centred on team projects. You will meet as a team of approximately five students each week to tackle a project of real significance to society under the guidance of School staff and tutors. The lectures are designed to give you tools for use in tackling your project and to stimulate your thinking about issues that you will face when you graduate.*
>
> *You can think of your engineering degree program as a "project" and the skills learnt in this course will help you to manage this four year project and bring it to a successful outcome.*

To give an idea of the logistics of running ENGG1000, in 2007 approximately 850 students took the course resulting in 180 teams consisting of 4 or 5 students each.

The team project, given to the student teams at the beginning of semester, accounts for 50% of the assessment in ENGG1000. The remainder of the course marks are accounted for by individual assignments addressing core engineering competencies such as use of spreadsheets and report writing (42.5%) and a reflective journal (7.5%).

The course forms one part of the transition strategy for first year students employed by the School of Engineering. For the first year student, ENGG1000 is not just about the learning objectives but it is an introduction to the community of practice, a vehicle for transitions into university life, and a place where they can find guidance and develop a sense of belonging to a student cohort. In this context the tutors in this process need to be more than technical instructors as their role encompasses duties from team mentor to coach. Tutors are therefore assigned teams at the beginning of semester and they stay

with the team throughout semester addressing technical, time management, and team issues as necessary.

It should be noted that the benefits of this system are not simply one-way from the tutors to the students. The tutors gain from the experience by expanding their 'people' skills; a valuable asset for their engineering careers. In addition, one project leader commented that tutoring ENGG1000, with all this entails, was a "*good bonding <experience> for tutors as a team*", that is not only were the students enhancing their team skills, so were the tutors.

Student perceptions

The students were not questioned specifically on the efficacy of the PETS process. They did however complete a number of blog sessions throughout the semester, one of which asked them about team dynamics and how knowing their Belbin team roles helped with the initial team formation. The following brief analysis arises from the examination of a random sampling of the 850 blog entries for this question.

Whilst the PETS process of mentoring, peer assessment, and individual reflection is communicated very clearly to the students at the beginning of semester (Table 1, 2.1 Communicate processes to student) the strategy for purposeful team selection (Table 1, 1.4 Allocate students to teams) is not. This means that the students take an active role in deciding team leadership rather than having a team leader nominated for them. When the students gather in their teams for the first time they come armed with the knowledge of what strengths and weaknesses they bring to the group; the discussion surrounding team deficiencies (and strategies to overcome such) forms the basis of the first meeting and acts as an icebreaker. As one student noted, "*being aware of this weakness will help me combat it*". They went on to say that "*the weaknesses you should worry about are those you're not aware of*". This is simply what the Belbin inventory does; it raises awareness where there may not have been before. Overall the student reflections were summed up by one student's comment *"<the initial discussion> helped us to start talking to each other. The Belbin analysis helped us know what to expect of each other for the semester and shape our management, we more or less were our Belbin types."*

Some students did have doubts about of the usefulness of the Belbin instrument. Ironically one disgruntled student who stated "*this whole Belbin test is a farce*", then went on to use Belbin tags to describe his team-mate's behaviours (completer, allocator etc). When prompted, another student reluctantly admitted "*I suppose my profile was accurate enough*". This leads the authors to reflect that the value in completing the Belbin instrument may not recognised even when it is apparent that the completion of the task has given the student a vocabulary to articulate and discuss problems and therefore aided team management as intended.

Students also noticed group dynamics flowing in a way that seemed natural: "*people seemed to automatically mould to a particular role*". As one student wisely noted "*helping each other out in our weaker skills is really going to determine how well we do in this project*", but more importantly they reflected that "*just capitalizing on each other's strengths won't be enough to finish the job*". Again, it is useful to reflect on what was not said by the students in that there was a remarkable reduction in the number of complaints about team members and team management with the introduction of the PETS process.

Staff perceptions

During a feedback session, project staff (project leaders and tutors) reported the efficacy of the PETS process in supporting team-skill formation with a mean score of 3.54 (*SD* 0.78, *n* 24) on a 5-point Likert scale (1 = poor efficacy, 5 = high efficacy). Figure 1 shows the spread of scores indicating overall acceptance of the process.

The project staff felt that using the PETS process ensured a diverse spread of students across the teams (Table 1, 1.4 Team Allocation), that it was good to ensure teams were given an 'ice-breaking' session (Table 1, 2.2 Team formation exercises) and that it reduced team failure. Some staff had worked with the ENGG1000 course during 2006 and commented that "*purposeful team selection appeared to work*

much better than the random model used previously" and that "*teams experienced fewer problems in this regard*". It was noted that "*most teams appeared to have a definite leader*", one project leader commenting that "*designated leaders made a positive difference*" although leaders were not 'designated' but rather 'distributed'. One of the project staff remarked that the Belbin test was most beneficial: *"teams could discuss and confront their inequalities and deficiencies"*.

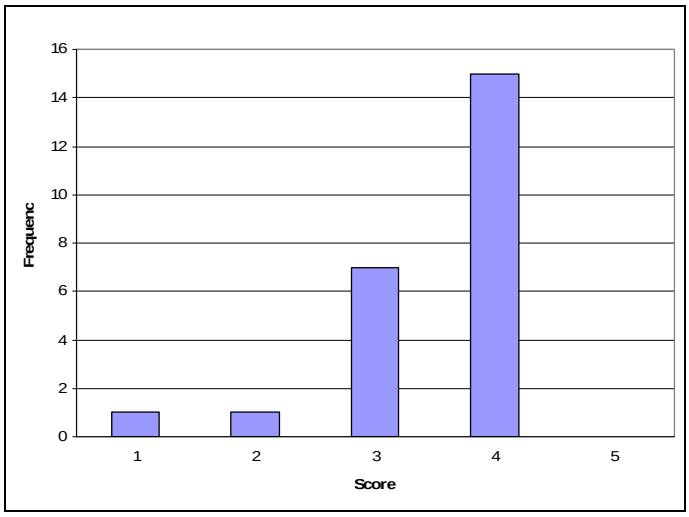

Figure 1 Staff response: *"How effective was PETS process in supporting team skill formation?"*

Most project staff also gave favourable feedback when asked how the student teams responded to the mentor meeting following administration of a formative PAF to their teams (Table 1, 3.1 Individual Student Reflection). The students responded by improving efforts and showed greater motivation (Table 1, 3.3 Address Social Loafing) and worked together to resolve problems in the group. A number of staff noted that many teams had resolved their own issues and required no intervention. Equally it must be noted that some teams were unwilling to discuss problems openly, and some students did not respond well to tutor feedback being particularly sensitive to the feedback provided.

The project staff were asked how effective they thought the PETS process was at addressing team dysfunction. Figure 2 shows the spread of these scores (mean 3.22, *SD* 0.9, *n* 20). The relationship between the generally favourable response does not appear strongly correlated with perceptions of efficacy yet 77.3% of staff had a 'good' opinion of the PETS process. It is also worth noting that 4 staff either remarked "don't know" or left this question blank. As with the students, the connection between the PETS process and team dysfunction is less clear perhaps because it relies on removing dysfunction rather than which is difficult to measure and/ or appreciate. Efficacy of the PETS process can also be shown by the fact that only 1 of the student teams, out of 180, failed through team dysfunction as measured by peer assessment.

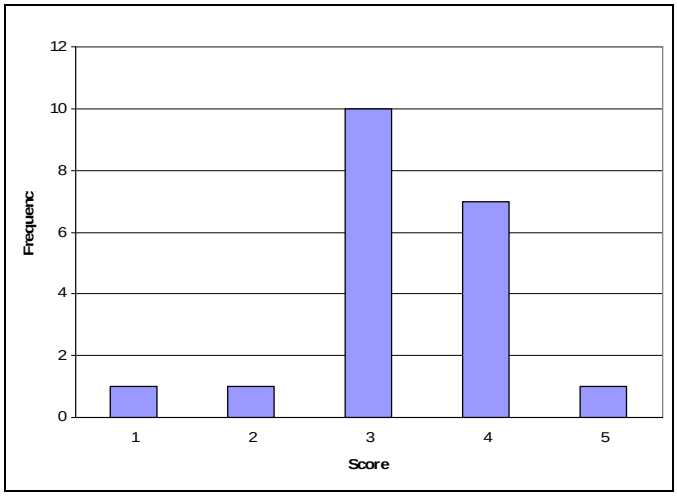

Figure 2 Staff response: *"How effective was the PETS process in addressing team dysfunction?"*

Project staff reflected (Table 1, 5.2 Teaching Team Reflection) that students had "*good engagement as teams*" and displayed good team bonding and direction. The staff noted the importance of good leadership during this project-based course and one staff member commented that the students had "*more teamwork awareness*". It is unclear if this was compared to the previous year or other project-based classes they had taught in. It was also mentioned that it was "*good that the PAF was anonymous*". This is a particularly important aspect of the PETS process. Another staff member suggested that the team members were "*too nice*" to one another when completing their PAF reflections and that they needed "*more truth*". It might be argued that this is part of the process of learning to behave in a team, learning to communicate needs and opinions tactfully to strangers and negotiating a way through the project pitfalls to a successful conclusion (all very important real-world engineering skills).

One member of staff was completely unimpressed with the PETS process, scoring both Likert-based questions with a 1, commenting that "*students did not take the PAF seriously*" and suggesting that the course should focus "*less on team management rubbish*". Another staff member suggested the purposeful team selection was not particularly useful in that the type of student attracted to engineering would mean the individuals would be too similar to be of value, additionally it was also suggested that "*students need to adapt*", inferring that a '*sink or swim'* approach would serve the first year students better. However these comments were more than balanced by the number of staff that saw value in the PETS process and their positive appraisal of the student teams.

Conclusions and recommendations

Overall it is thought that the application of the PETS process to ENGG1000 has succeeded in: reducing team failure due to dysfunction, reducing the number of student complaints about team processes, underpinning a transitional community of practice, and introducing students to team management strategies and team work skills.

However, the success of the PETS process is underpinned by the teaching team. Careful selection of both project leaders and tutors is vital. A project leader with a poor attitude to the process will not only have a negative effect on the students in their project, but also on the tutors that are part of the project team. This year, tutors for the subject were selected on the basis of availability and not for ability. Next year, Figure 3 will be used to advertise for interested participants in order to ensure buy-in to the values and objectives of ENGG1000.

A bit about the tutors

ENGG1000 tutors are required to do more than your average tutor but they get another skill set to put on their resume:

> *Practical knowledge and application of communication skills, mentoring and guidance of subordinates (1st year students).*

Is this you? Are you:

- interested in engaging with the 1st year students;
- compassionate;
- able to communicate on a number of different levels;
- willing to pass on your own experiences and knowledge;
- able to facilitate others learning (as opposed to spoon feeding); and
- able to recognise when a situation is out of your capability and refer accordingly.

Of course, we won't drop you in the deep end – there will be training and you will need to attend. Tutors will be required to undergo regular School of Engineering tutor training as well as specialised ENGG1000 training (Wks 2, 6 and Swot Vac). There will also be support available to you via both your project leaders and Jasmine (1st year coordinator).

Figure 3 ENGG1000 tutor job description

References

Belbin R.M. (1993) Team roles at work, Butterworth-Heinemann, Oxford.

Blair, G. M. (1993) Laying the foundations for effective teamwork. Engineering Science and Education Journal, February**,** 15-19.

Burtner, J. A. (1997) Teaching freshman students to assess team performance. In *ASEE Annual Conference*, Vol. Session 2793.

Courtney, P. and Rouse, A. (2006) The emotional impact of learning in small groups: highlighting the impact on student progression and retention. *Teaching in Higher Education*, **11**(1): 79-91

Foyle, H. C. (1995) Interactive learning in the higher education classroom, National Education Association, Washington.

Gardner, B. S. and Korth, S. J. (1997) Classroom strategies that facilitate transfer of learning to the workplace. Innovative Higher Education, **22** (1)**,** 45-60.

Grulke, E. A., Beert, D. C. and Lane, D. R. (2001) The effects of physical environment on engineering team performance: A case study. Journal of Engineering Education, **90** (3)**,** 319.

Huxham, M. and Land, R. (2000) Assigning students to group work projects. Can we do better than random? *Innovations in Education and Training International* **37**: 17-22

Johnson, D. W. and Johnson, F. P. (2003) Joining together: group theory and group skills, Pearson, Boston.

Jones, D. (1996) Team learning approach in education, *J. Quality and Participation*, **19** (1): 80-87.

Kavanagh, L. and Crosthwaite, C. (2007) Triple objective mentoring: achieving learning objectives with chemical engineering students, IChemE Trans D, 2: 68-79

Michaelsen, L. K. (1995), Getting started with team learning. Accessed: 23 April 2004, http://www.ou.edu/idp/teamlearning/index.htm

Moy, J. (1999) The impact of generic competencies on workplace performance. *Review of Research Monograph Series*. Adelaide: National Centre for Vocational Education Research

Schlimmer, J. C., Fletcher, J. B. and Hermens, L. A. (1994) Team-oriented software practicum IEEE Transactions on Education, **37** (2)**,** 212-220.

Shelnutt, J. W., Middleton, S. G., Buch, K. A. and Lumsdaine, M. (1996) Forming student project teams based on Hermann brain dominance (HBDI) results In *ASEE Annual Conference*, Vol. Session 0630.

Smith, K. (1996) Cooperative learning: making "groupwork" work. *New directions for teaching and learning*, **67** (Fall): 71-82

Walker, C. and Angelo, T. (1998) A collective effort classroom assessment technique: promoting high performance in student teams. New Directions for Teaching and Learning, **75** (Fall)**,** 101-112.

Zeff, L. E. and Higby, M. A. (2002) Teaching more than you know. Academic Exchange, Fall**,** 155-160.

Acknowledgements

The authors would like to acknowledge the support of all academic staff and postgraduates involved in ENGG1000, 2007.

Copyright statement